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AMERICAN
DYESTUFF REPORTER

VOLUME 41 September 1, 1952 NUMBER 18

THE DYEING OF TEXTILE FIBERS AT HIGH TEMPERATURE

L DRIJVERS

Teinturerie de Groeninghe
Courtrai (Belgium)

A MACHINE for dyeing at high temperature (above 212°F) has been devised by Baudouin Steverlynck of the Teinturerie de Groeninghe, Courtrai, Belgium, and after three years of experimentation and study is now easy to operate. The machine and the dyeing method will be of interest not only for the dyeing of viscose rayon cakes, but also for the dyeing of other synthetic fibers, such as nylon, perlon, and Orlon, as well as the natural fibers.

The fundamental principle of this new method is based on the fact that dyeing of vegetable, animal and synthetic fibers is accomplished by physico-chemical (or purely chemical) reactions which, being reversible, create a state of equilibrium, after a certain period. This state of equilibrium and the rate at which it is established are a function of the temperature.

An elevation of the temperature above the usual dyeing temperatures (140-203°F) seemed preferable therefore not only for shortening the dyeing time, but primarily for the purpose of improving the uniformity of the results obtained.

Although the trials carried out by the Teinturerie de Groeninghe were at first made on equipment under static pressure with the sole aim of facilitating the dyeing of rayon cakes, it at once became apparent that its application to other textile fibers would be equally important. We shall therefore study, using different fibers, the principle of this new dyeing method.

CELLULOSIC FIBERS

DYEING WITH DIRECT DYES

For a greater insight into the influence of the "temperature" factor, it is necessary to get a clear idea of what happens when fibers and dyestuffs are placed together in water, i e, what happens during dyeing.

Dyeing by the methods normally employed requires a long time. According to present day theories dyeing takes place in three phases:

(1) *The diffusion of the dye in the bath towards the surface of the fiber.* As a result of residual valencies, the molecules of the dye have a tendency to aggregate in the dyebath; the degree of aggregation differs from one dye to another, e g, Benzopurpurine is more highly aggregated than Sirius Red 4B. At each temperature, a state of equilibrium is reached between the amount of dye in the molecular state and the amount in the aggregated state.

dyestuff $\rightleftarrows$ dyestuff
(molecular) (aggregated)

(2) *Adsorption on the surface of the fiber.* The molecularly-diffused dye comes into contact with the fiber through the movement of the bath and an adsorption phenomenon occurs until equilibrium is established.

dye (on the surface of the fiber) $\leftrightharpoons$ dye (molecular in the bath)

(3) *Diffusion into the fiber.* The dye adsorbed on the surface of the fiber has to penetrate into the intercrystalline spaces of the macro-molecule of the cellulose. This penetration proceeds slowly because of the mechanical resistance encountered by the dye in its progress through the fiber. This accounts for the rapid accumulation of dye on the surface of the fiber and also for the time taken to reach equilibrium.

dye $\rightleftarrows$ dye
(surface) (molecule in the bath)

It follows from this that adsorption cannot continue unless diffusion into the fiber is also proceeding. The latter is therefore of supreme importance, not only because it ensures a good fixation of the dye——and thus good resistance to rubbing——but also because it governs the speed of the dyeing processes.

It is an acknowledged fact that a high dyeing temperature greatly assists the phenomenon of penetration.

The physico-chemical equilibria described above can be shifted by the presence of electrolytes, but the rate at which they are reached is principally a function of the temperature.

On placing a cellulosic fiber in contact with a dyebath an equilibrium is finally produced that depends on the temperature and constitution of the bath. However, the dyeing of a mass of fibers in a circulating system is more complex.

Figure 1 diagrammatically represents a mass to be dyed in a circulating system, which circulates in the direction indicated by the arrows. At the start of the operation, i e, on setting the dyebath in motion, the layer aa′ in direct contact with the fresh bath will absorb more dye than the successive layers. The bath, now partially exhausted, comes into contact a second time with the mass already dyed. With equilibrium existing between the amount of dye adsorbed by the surfaces

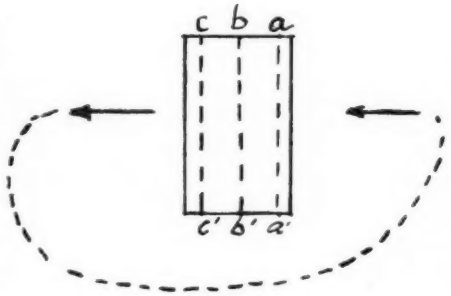

Figure 1

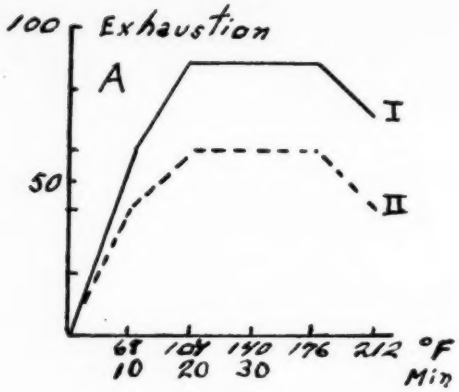

Figure 2

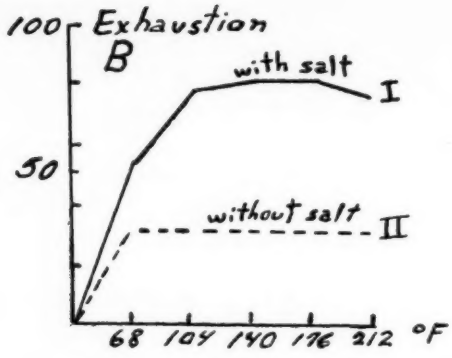

Figure 3

of the fibers and the concentration of the bath at this point, there occurs a desorption of dye in layer aa' towards the dyebath, i e, an enrichment of the bath. A new equilibrium is reached in the fibers at layer bb', reflected by an intensification of the coloration at this point.

The layer cc' undergoes the same phenomenon.

The repeated circulation of the bath thus alternately creates phenomena of desorption and adsorption, so inducing migration of the dyes from the dark parts to the light parts until, finally, a tinctorial equilibrium is reached between the whole of the mass being dyed and the dyebath.

The fundamental principle, the application of which ensures levelness in dyeing, is as follows: "In a dynamic system (dye solution/mass to be dyed) no change whatever, so far as the practical exhaustion of the bath is concerned, can be achieved as long as tinctorial equilibrium has not been reached between the entire mass and the whole of the bath."

Even if this principle does not constitute the general and absolute rule, experience has shown that its application (which is, after all, only possible at high temperature) is necessary in order to obtain good results on rayon cakes.

The principal factors that can influence this system are the temperature and the concentration of the electrolytes.

From what has been said above about the action exerted by temperature on the dyeing process, it is clear that this factor has an important effect on the speed with which the dynamic equilibrium (as defined) is reached. Characteristic of each dyestuff are the manner in which the equilibrium is obtained and the amounts of dye and mass to be dyed present at the moment of equilibrium.

Dyestuff manufacturers have been trying for some time to illustrate by graphs the more important dyestuff properties, and they have produced exhaustion curves under clearly-defined conditions of their own particular ranges of dyestuffs. It is found to be impossible to express by a simple mathematical formula or to illustrate by a single graph the different factors capable of influencing dyeing, i e, the temperature, dye concentration, electrolyte concentration, bath ratio, etc.

To overcome the difficulty, some of these factors have been regarded as constants, while the temperature and the electrolyte concentration have been regarded as variables. Although the values given to the constants are not strictly accurate, since equilibrium for each dye cannot be obtained in the time assumed, these diagrams are for the most part sufficiently characteristic of the different types of dyestuffs. In any event, these diagrams are exact enough to serve as a basis for industrial application.

The Society of Dyers and Colourists has classified substantive dyes into 3 groups, Class A, Class B and Class C.

CLASS A. DYES POSSESSING GOOD MIGRATION PROPERTIES ——— This class includes Sirius Red 4B. To find the exhaustion curve of this dye, dyeings were made in a specified time and under the following conditions:

(I) with addition of sodium carbonate and salt to the dyebath, and

(II) without these products, both at 68, 104, 140, 176, and 203°F, respectively, after 2, 10, 20, 30 and 45 minutes. Exhaustion of the baths was measured by colorimetric analysis of the exhaust liquors. The dyes of this class have a curve which descends from a maximum around 176°F; this is merely the graphical expression of the fact that, beyond that temperature desorption occurs and, as a result, migration of the dye can take place. (See Figure 2)

It seems evident that for this class of dyestuffs, the curve, such as has been estab-

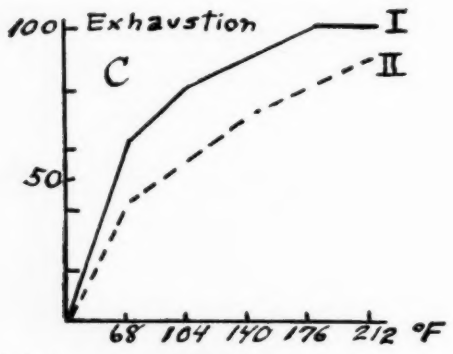

Figure 4

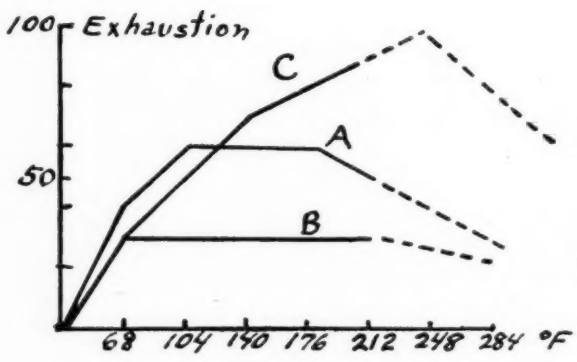

Figure 5

lished, resembles the theoretical equilibrium curve at about 175°F. The curve will therefore necessarily be falling off, because at equilibrium the quantity of dye adsorbed diminishes with the temperature.

DYES OF CLASS B——A second group comprises the dyes which are sensitive to electrolytes and intensitive to an increase of temperature.

A typical representative of this group is the tetrasulfonated dyestuff Chloramine Pure Blue FF. It is noteworthy that curves I and II rather have the appearance of straight lines parallel to the temperature axis. The influence of an increase of temperature is barely perceptible (Figure 3).

DYES OF CLASS C——The third group comprises the dyes that are sensitive to temperature. As a typical example, we may mention Benzopurpurine 10B.

The difference of the dyestuff of Class A from those of Class C exists in the varying speeds of establishing dyeing equilibrium. The inertia of Class C dyestuffs is not removed at 212°F.

The exhaustion curve is a rising one, at least up to a temperature of 212°F (see Figure 4). All the graphs published at the present time finish at 212°F, since dyeing at temperatures over that figure has hitherto been an unexplored domain.

In the course of experiments which we have carried out at temperatures above 212°F, we have found that all the curves have a tendency to fall off towards the abscissa; characteristic of each dyestuff is the point at which the curve bends (Figure 5). From the corresponding temperature at this point, the exhaustion curve approaches equilibrium; consequently it will be falling off at high temperatures.

In this light, Class C would differ from Class A only in that migration of the dye begins at a higher temperature.

We have been able to show by numerous experiments using temperatures above 212°F that extrapolation of the curves beyond that point is permissible and that the theoretical conclusions are in agreement with the facts.

We have already drawn attention to the fact that, in addition to the temperature, it is necessary to take into account a second variable factor, the "salt concentration". Modification of this factor enables us to draw an indefinite number of curves between I and II, each of which relates to a clearly defined concentration of electrolytes.

The aim of dyeing is to achieve, by the greatest possible exhaustion of the bath, a very high yield of fixed dyestuff.

The end point of the dyeing process for the graphs of Classes A and B lies between 176 and 194°F. For the dyestuffs of Class C this end point lies beyond 212°F.

In the present-day method of dyeing one makes the curves ascend by raising the temperature of the dyebath slowly. In the method of dyeing that we have elaborated, the temperature is increased as rapidly as possible in order to reach the opposite slope where high temperature promotes more rapid diffusion of the dye into the fiber and, consequently, the rapid arrival at the physico-chemical equilibria. Once these equilibria have been reached at the working temperature, the curve is re-ascended by cooling the bath.

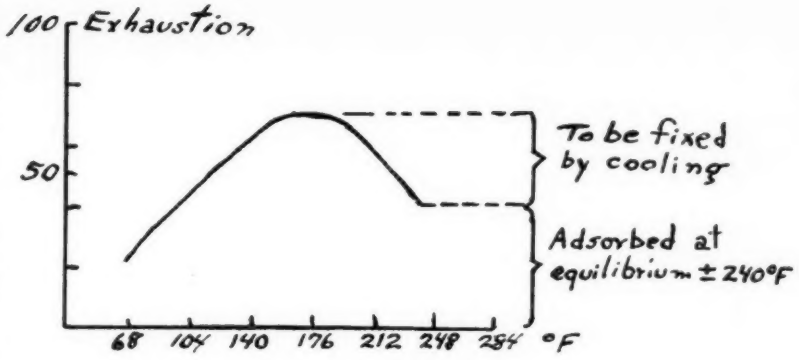

Figure 6

From this fact, several important points deserve consideration.

(1) *The maximum temperature to be reached.* For dyes of Class A, this is of the order of 221°F. For those of Class B, characterized by a straight line rather than by a curve, excellent dispersion and, consequently, rapid penetration into the fiber are obtained at about 230°F. For dyes of Class C, judging from the few trials made, this temperature lies at around 248-257°F.

(2) *The time taken to reach equilibrium at the maximum temperature.* This is different for each dye. It varies from 30 to 45 minutes on Fabelta rayon cakes of 550 g.

(3) *The speed and duration of cooling of the dyebath.* It is during cooling of the bath that a large part of the dye goes on to the fiber.

(4) *The progressive addition of salt.* The foregoing remarks show that the state of equilibrium is reached very quickly at high temperatures. Equilibrium is necessary for achieving perfect levelness, in accordance with our enunciation of the fundamental principle that must underlie every process in the dyeing of rayon cakes. The gradual addition of salt enables one to follow progressively all the equilibrium curves situated between Curves I and II; furthermore, the high temperature enables us to reach these equilibria in a shorter time and consequently to pass through this phase of the dyeing very quickly.

Our process, in short, is merely a method of dyeing by temperature control, but applied in the inverse order.

We may represent this dyeing process by Figure 6.

A few examples will better illustrate the procedure in the dyeing of Fabelta rayon cakes 550 g, brilliant, 150 denier (Figures 7, 8, 9 and 10).

Figure 7 represents a dyeing with Sirius Red 4B (Class A). The dyeing proceeds from point A in Curve I (i e, in the presence of the total quantity of electrolyte) at a temperature of 230°F. It takes approximately 60 minutes to reach equilibrium. The second phase from A to B occurs by cooling in 30 minutes.

Figure 8 shows that the dyeing of

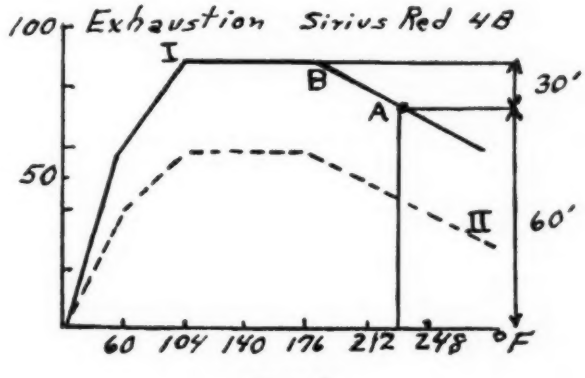

Figure 7

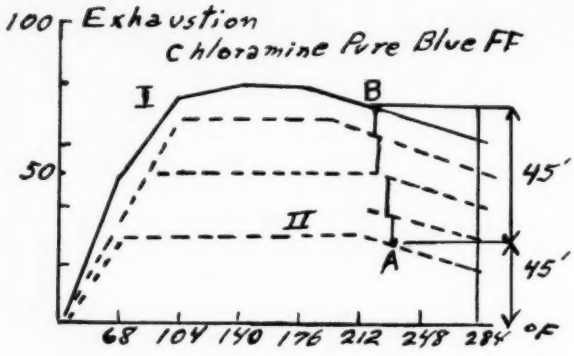

Figure 8

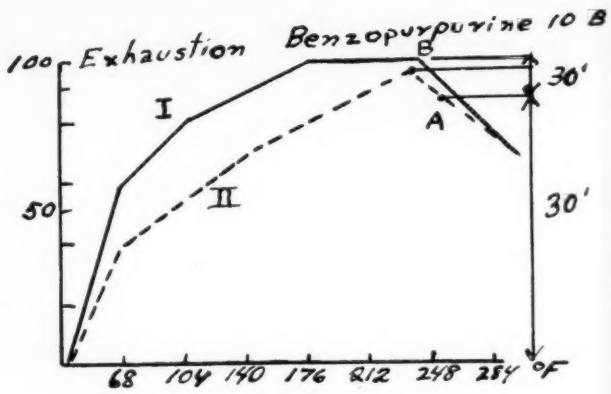

Figure 9

Chloramine Pure Blue FF (Class B) proceeds from point A on Curve II (i e, without electrolyte) when equilibrium is attained after 45 minutes. The transition from A to B is made with slow additions of salt over a period of 45 minutes.

In Figure 9, the Benzopurpurine 10B (Class C) is dyed from point A at 257°F when equilibrium is reached in 30 minutes. The cooling from A to B takes place in 30 minutes.

Figure 10 represents the procedure as applied to Trisulfor Brown BP (Class C). Dyeing commences at A, when equilibrium is realized in 45 minutes, proceeds to B after successive additions of salt and is completed at C through cooling of the bath.

In our trials with the dyes of Class A and B, we obtained the exhaustion curves by extrapolating beyond 212°F graphs published by the dyestuff manufacturers. For Class C we were obliged to look for the main characteristic, notably the temperature at which maximum exhaustion was obtained. It is evident that, for economic reasons, only those dyes whose maximum exhaustion is not beyond a certain limit will be worth considering for practical application.

Many direct colors are reduced at these high temperatures. Some are very sensitive, such as Chlorantine Light Fast Blue 2GLL and 3GLL, especially under slightly alkaline conditions (soap or soda). Certain organic products resulting from the decomposition of cellulose act as reducing agents capable of destroying the azoic bond of the dyestuff molecule. It is advisable to avoid any alkalinity of the bath and to add to the bath, in small doses, oxidizing products such as H_2O_2 and perborates. Since these products easily lose their oxidizing ability from 176°F on, some dyestuffs, such as Solar Green BL (the most sensitive to reduction that we have found) are decomposed after a rather short time.

Good results have been obtained, even for extremely sensitive dyes, with a small dose of Du Pont's vat developer, provided the dyeing is done in a neutral medium.

As for the different fastness properties of dyeings obtained by this process, it is our experience that no important change occurs. But it would be interesting in any event to make a systematic study of the question from the point of view of the preservation of the different fastness indices.

VAT DYESTUFFS

The importance of this class of dyestuffs impels us to make a more detailed study of their behavior in dyeing at temperatures higher than those normally employed.

These dyestuffs, which are insoluble in water, must first be converted into their leuco derivatives by reducing agents. Of all the factors influencing absorption of the reduced dye and the speed of diffusion in the fiber, temperature is the most important.

Before embarking on a study of a method of dyeing at high temperature, it was necessary to see how the leuco derivatives of the anthraquinonoid dyes behave at high temperatures.

The dyestuff manufacturers in their dyeing cards indicate which methods give the maximum tinctorial yield. These methods are known as CI, CII and CIII for Ciba; 1, 2 and 3 for ICI; A, B and C for Francolor; and IN, IW and IK for the former I G. These methods differ among themselves in the amounts of caustic soda necessary to keep the leuco in solution and in the temperature at which the exhaustion is most favorable.

By a certain analogy to the classes of direct colors, each of which is characterized by a typical exhaustion curve, the leuco derivatives of vat dyes can also be classified into these same classes, which correspond approximately to Classes IN, IW and IK.

It is a known fact that the leuco derivatives of Class IK begin to migrate at temperatures above 104°F. The exhaustion of the dyebath may be represented by a graph which has the same shape as that of the direct dyes with good migration (Class A). Class IN behaves, on the contrary, like the dyes that are sensitive to temperature. From these facts, it was obviously necessary to evolve a method of high temperature dyeing for the dyestuffs. In practice, this method, when applied to rayon cakes of 550 g at 194-221°F, gives excellent results in one hour's time. However, not all the dyes will tolerate this temperature in the reduced state. Indeed, some of them may undergo overreduction, intramolecular displacement of atoms, a loss of a benzoylamino group by fission, or dehalogenation at these temperatures. These changes in turn bring about a change of shade or an impairment of the fastness properties.

This sensitivity to temperature does not apply to the dyes in the oxidized state, so that for an application at high temperature only a process of pigmentation is feasible.

In the Abbot-Cox process, applied to viscose rayon, the pigmentation is generally done around 194°F with finely dispersed dyes, which fix themselves superficially on the fiber, where they are ultimately fixed in situ by a reduction. These pigments have no substantivity for cellulosic fibers in the sense that direct dyestuffs have. Between certain determined limits of temperature, and with a certain reserve to which we shall revert shortly, the adherence of the pigments to the fiber follows a curve more or less similar to that of the exhaustion of direct colors sensitive to electrolytes (Class B).

Several dyestuff manufacturers have recently put on the market some finely divided vat dyes possessing colloidal properties approximately the same size. Although the various firms advise against pigmenting at the boil, we are currently achieving pigmentations at 230°F with Colloisols (BASF) Caledons F D (I C I) and Ultra Ponsols (Du Pont). These pigments also behave more or less like direct colors sensitive to salt, with the difference that below the critical temperature they are slightly sensitive to temperature. When the bath is heated to the critical temperature, they have a tendency to coagulate and are precipitated on the external parts of the mass to be dyed.

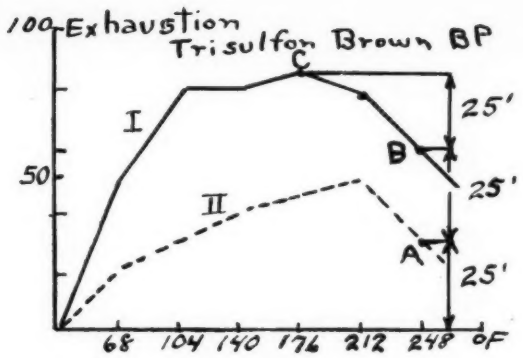

Figure 10

As products promoting the dispersion of the pigments, various firms recommend the use of nonionics. Because they have a relatively low turbidity point, however—in the vicinity of 212°F—our preference has been for a slightly anion-active product, such as Nekanyl LS, whose turbidity point is higher and whose dispersing power is not impaired by raising the temperature to 230°F.

The high temperature dyeing process allows us to achieve very level pigmentation in a minimum of time. Thus, we have obtained pigmentation of pale shades in 30 minutes and of deep shades in 60 minutes. The degree of levelling obtained by the pigmentation enables us to shorten the reduction time so that the two phases, pigmentation and reduction, are complete in less than 2 hours.

By virtue of the heat exchange unit incorporated in our machine, we are able to reduce the temperature in a very short time from the high level employed for pigmentation to the much lower level necessary for reduction.

DYEING OF WOOL

The problem of the high temperature dyeing of protein fibers, e g, wool, has also been one of the objects of our researches. If the dyeing of cellulosic fibers principally involves physico-chemical phenomena, the dyeing of wool is manifested rather by purely chemical reactions. As these are activated by an increase of temperature, it is quite natural that we should want to know its effect on the dyeing process.

The kinetics of wool dyeing has not been studied hitherto as much as it has been for the dyeing of cellulosic fibers. A systematic study of the chemical reactions underlying the dyeing of protein fibers has not yet been made.

The results of laboratory trials are outlined in two sources (*1, 2*), in which microscopic cross sections of dyed wool fibers illustrate clearly the rapidity at which wool dyeing occurs at temperatures of the order of 230-268°F. Nowhere do we come across data relating to industrial application of a high temperature dyeing process.

The chemical reactions underlying wool dyeing take place in a solid/liquid heterogeneous medium, governed by well-defined laws which, according to Schäffer (*3*) are not sufficiently taken into account. He describes the phenomena governing wool dyeing as follows:

> If a solid substance is immersed in a solution in which it can react chemically with the dissolved substance, a dynamic equilibrium is set up on its external surface; the interior mass of the solid, covered by the contact surfaces, takes no part in the equilibrium reaction.
>
> If the solid substance is capable——by its special structure——of swelling in the solvent, its increasing volume results in an increase in the surfaces of contact with the liquid. If the swelling continues to the point where every molecule of the solid comes into contact with the reacting liquid, there will no longer exist any inactive material, i e, which takes no part in the reaction. When this ideal condition has been reached, the dynamic equilibrium becomes equal to the chemical equilibrium. Now wool fiber is capable of swelling. It is made up of layers parallel to the longitudinal axis and is composed of polypeptide chains linked together by organic bridges, and principally by cystine links. In the dry state, these layers are pressed one on top of another. At high temperature, the spaces between these layers increase, thus favoring the diffusion of acids and dyes dissolved in the solution.
>
> This widening of the spaces is already noticeable around 212°F, especially at a relatively low pH. The dynamic equilibrium is close to the chemical equilibrium. Experience on the one hand and photographs of microscopic cross-sections on the other show plainly that the reaction reaches a state of equilibrium after one hour of dyeing at the boil.
>
> If the dyeing is carried out at higher temperatures, e g, about 230°F, this widening of the spaces between polypeptide layers occurs instantaneously, thus permitting the chemical equilibrium to be established immediately.

The following table (*4*) indicates the minimum time necessary for the establishment of the equilibrium, taking as unity the time needed at 212°F to achieve this aim:

	212°F	*176°F*	*140°F*	*104°F*	*68°F*
Wool (leveling acid dyes)	1	5	30	300	3.5
Wool (milling dyes)	1	5	65	900	14.0

Extrapolation in the neighborhood of 230-239°F will give an idea of the influence of temperature on the rate of the reaction. A description of the chemical process of the reactions that take place in the dyeing of wool would be very lengthy; both in an acid bath and in a neutral bath, the reactions involved are always reversible, and the higher the temperature, the sooner equilibrium is reached.

Royer, Zimmerman, Walter and Robinson (*2*) illustrated by microscopic cross sections the fact that penetration into the wool fiber is effected practically in a few seconds at temperatures of 248°F. Trials carried out on an industrial scale have proved that a method of high temperature dyeing presents many advantages as regards the levelness, penetration, dyeing time and exhaustion of the bath; the fiber retains its properties completely, and shrinking is less than in the usual process at 212°F. Different examinations of fibers dyed at high temperatures have proved that the mechanical properties of the fiber have undergone no change. This last fact suggests that the degradation of a fiber is also a function of the time exposed, since the fiber seems to be degraded less by a short exposure at a high temperature than by a longer time of exposure at a lower temperature.

Acid dyes with a very poor levelling power, such as Xylene Milling Blue 60 and Sulfonine Orange R, give level dyeings on cross wound bobbins after a few minutes' dyeing.

The high temperature process enables level dyeings to be obtained with the chromable dyes, the Carbolens, while reducing the dyeing times.

It is surprising that shading at these high temperatures no longer presents any difficulties; even those dyes with a known poor levelness rating can be used for shading without special precautions.

SYNTHETIC FIBERS

The dyeing of synthetic fibers necessitates in general a longer time than that of other textile fibers. The reason lies in their poor swelling ability in water, which prevents diffusion of the dyes into the interior of the fibers under the usual conditions of dyeing. Nylon and perlon possess

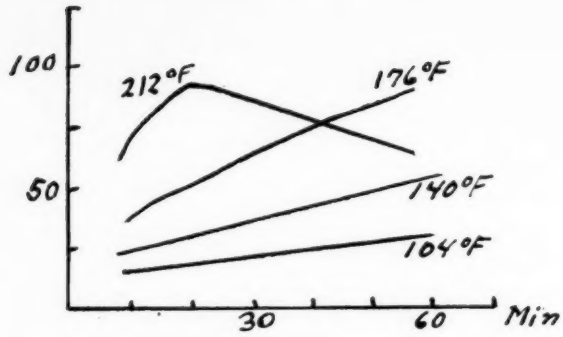

Figure 11

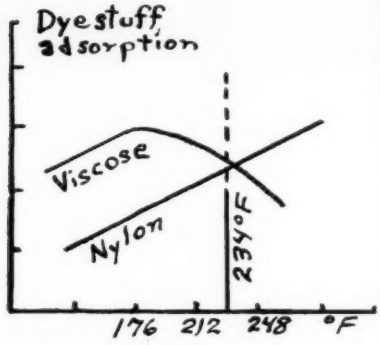

Figure 12

this resistance to swelling in an appreciable degree but this property is even more pronounced with fibers such as Acrilan, Orlon, Terylene, etc.

A. DYEING OF NYLON———Nylon or perlon can be dyed with acid dyes, dispersed or water soluble acetate dyes, and also with some direct dyes and vat dyes.

(a) *Acid Dyes.* Few acid dyestuffs will build up to give heavy shades on nylon. The reason for this is that the molecule of the nylon base has very few reactive groups. The use of high temperatures for dyeing cannot remedy this. Below 212°F acid dyes do not easily cover the fiber irregularities. We have not yet experimented to see whether high temperature might improve the migrating power.

Chromable dyes dye without difficulty around 239° F. The chroming is also done at this temperature.

(b) *Dispersed Dyes (Perliton).* The chemical process involved in the use of these dyes on acetate or nylon differs entirely from that in the dyeing of other fibers, such as the fixation of substantive dyes on cellulose or that of acid dyes on aminated fibers. These dyes are adsorbed by capillarity, then fixed by hydrogen bonds. The pores of nylon measure 5 to 10 Å, while those of wool and of cotton are 40 and 60 Å, respectively.

It seems obvious that an increase of temperature must have a favorable effect on the increase of these small dimensions. On the other hand, high temperature promotes dispersion of the dyes and consequently their adsorption. Practice has entirely confirmed this theory to such a degree that these dyes present no difficulty in dyeing.

Vickerstaff gives some figures relative to the time required to reach adsorption equilibrium at several temperatures. He takes as unity the time required to attain equilibrium at 212°F.

	212°F	*176°F*	*140°F*	*104°F*	*68°F*
Time	1	5	30	300	3.500

Also, he gives exhaustion curves for Dispersol Fast Red R 150 on nylon as a function of the time at several temperatures (see Figure 11).

All these data allow us to conclude, by extrapolation, that at temperatures around 239°F, the equilibrium state will be attained instantaneously. Practical tests confirm this. In (*1*) the authors illustrate by miscroscopic cross sections a fiber nylon dyed with dispersed dyes. Diffusion into the fiber, around 248°F, is total after some seconds. This result cannot be obtained at 212°F. Just as levelness presents no problem at that temperature, shading can be done in a few seconds.

(c) *Metalliferous Dyes:* Vialonecht (B A S F) and Capracyl (Du Pont) dye nylon or perlon at 248°F without the slightest difficulty. The fastness to rubbing of the full bodied shades, even of black, is excellent.

(d) *Soluble Dyes for Acetate (Solacet).* We can say the same things as for the dyes under (b).

(e) *Direct Colors.* The adsorption of many direct colors on nylon is very poor. This is due to the fact that the molecules of these dyes (which have a high molecular weight) have dimensions too large to permit them to diffuse into the relatively small pores of the fiber. Dyes which migrate on cellulosic fibers generally dye nylon very well. Temperatures of over 212°F in general give instantaneous equilibrium and very level dyeings.

(f) *Vat Dyes.* The process by pigmentation, such as we have described for the dyeing of viscose with vat dyes, offers few possibilities. On the other hand, the leuco derivatives can give very level results. At the customary temperatures, they do not dye nylon or perlon. From 212°F on, adsorption of the dye occurs rapidly.

The importance of vat dyes for the dyeing of nylon is gravely affected by their failing in regard to light fastness. It is necessary to select the most suitable.

B. THE DYEING OF ORLON———

(1) *With Acetate Dyes.* Several acetate dyes dye Orlon very readily at a temperature of 266°F. It seems absolutely essential to go up to this temperature in order to obtain a sufficient dilatation of the pores to render possible the penetration of the dye.

(2) *With Acid Dyes.* Dyeing is also done at 266°F in the presence of cuprous salt.

C. DYEING OF ACRILAN———This seems easier than that of Orlon. Temperatures of 248°F are sufficient for the dyeing of acetate dyes, acid dyes, direct dyes, metalliferous dyes, such as Capracyl, etc.

DYEING OF MIXED FIBERS

To conclude this account we should like to indicate the possibilities of our method of dyeing at temperatures above 212°F for mixed fibers. To date, the solution to the problem has been sought in the choice of suitable dyes; we have no current knowledge of any recourse to temperature to provide a solution to the difficulty of tone-in-tone dyeing of mixed fibers. A typical case is the dyeing of mixed perlon/viscose fibers with Benzo Copper dyes. Figure 12 illustrates the method employed with Benzo Copper Brown NL.

Around 234°F the two fibers are dyed uniformly. With other Benzo Copper dyes, which on viscose show a substantivity curve falling beyond 212°F, the results likewise have been excellent. All substantive dyes, characterized by a similar curve, are capable of giving the same results.

As for other mixtures of fibers, e g, wool/nylon, it seems clear that the choice of temperature will provide a solution to many difficulties. A series of experiments is in progress with the metalliferous dyes Capracyl and Vialon, but it is too early to reach any conclusions.

EQUIPMENT

At about 212°F and even from 185°F, the vapor tension of the liquid increases to such a degree that the normal working of centrifugal pumps, which are generally used in pressure dyeing machines, is greatly impaired. Their efficiency at this point becomes very poor and may even fall to zero. To neutralize the adverse effect of the vapor tension, it is necessary to apply a static

pressure to machines operating at 212°F and over.

This static pressure is produced in the machine itself, where the expansion caused by heating of the bath compresses the enclosed air in an expansion vessel.

The pumps under ideal working conditions give maximum efficiency and may be considerably reduced in size; in your machines the motive force is barely 1/2-1/3 of that of the machines generally employed.

The rate of flow plays a major part in the setting up of tinctorial equilibrium between the mass to be dyed and the dyebath. If the bath moves in an irregular manner through the mass to be dyed, an excess flow will possibly give a good result; but the risk of forming channels and of spoiling the goods at these places ——particularly in the case of rayon cakes ——is thereby greatly increased. The flow should be reduced at the same time as the dynamic pressure of the pump; the principal requirement is not that the rate of flow should be a copious one, but that it should be distributed uniformly throughout the mass to be dyed. In our equipment this is achieved.

The homogenity of the rate of flow throughout the mass to be dyed is influenced favorably by raising the temperature, especially in the case of rayon. Its swelling power, at a maximum around 122°F, is reduced by raising the temperature. In this way the best conditions are created for the passage of the bath.

As another feature of the equipment we may mention that all additions of reagents and shading dyes can be made without releasing the pressure and that, by means of a small shading box running parallel to the machine proper, it is possible to take samples regularly and thus follow the progress of the dyeing.

The machine is truly universal in the sense that it can dye the various textile materials in whatever form they happen to be.

For the machine in question, patents have been applied for in the majority of industrial countries; patents have already been granted in Germany, France, Belgium, Switzerland, etc, and are pending in the U S A and United Kingdom.

CONCLUSION

The results arrived at industrially over 3 years enable us to conclude that a dyeing process at over 212°F ensures a whole series of advantages in regard to levelness, exhaustion of the bath, and elimination of irregularities of shade in mixtures of rayon from different sources. This last point will be important for the dyeing of rayon fabrics. The stability of the majority of fibers at these high temperatures has been proved; that of the dyes has likewise been made practicable.

There remains another important field to explore, a systematic study to be accomplished. For our part, we hope that the research that we have done and the experience which we have gained in this field will have contributed towards a new advance in the dyeing of textiles.

REFERENCES

(1) "Some Phases of High Temperature Dyeing," *Am Dyestuff Reptr* 38, P9, Jan 10, 1949.

(2) "Dyeing Studies at Elevated Temperatures," *Textile Research J*, Oct, 1948.

(3) *Handbuch der Färberei*, Vol II, p 144.

(4) Vickerstaff, "The Physical Chemistry of Dyeing," p 86; p 131.

ABSTRACTS

Testing of Water-Repellency A Description of the Swedish Rain-Tester

E M Kärrholm, *J Textile Inst* 43, P263-89, June, 1952.

There exist many different methods for testing water-repellency. The methods using some type of artificial rain are most closely connected with the actual use of a water-repellent fabric. The Bundesmann apparatus, which is of this type, is widely used in Europe. It is, however, considered to be unnecessarily complicated, and another type of apparatus has been designed by the Swedish Committee for Textile Testing Methods and built at the Swedish Institute for Textile Research.

The design of this new rain tester is described in much detail, with illustrations. The water drops are formed by means of 121 glass capillaries, connected to a bottle with constant water level, which may be raised or lowered to vary the intensity of the rain. Both the absorption and the penetration of water are determined for each sample.

The influence of the following factors on the test result has been investigated: the intensity of the rain; the temperature of the water; the hardness and pH of the water; the amount of absorbed water as a function of the time of exposure to the rain; and the height of fall of the water.

A comparison with other test methods was made. The absorption of water was compared with the dynamic absorption test (*Textile Research J 17*, 497, 1947). These two tests do not grade the fabrics in the same order. This probably depends on the fabric in one case being subjected to falling water drops (the Swedish rain tester) while in the other the fabrics move in water. The Swedish rain tester gives a higher sensitivity for wool fabrics.

The penetration of water obtained with the Swedish rain tester was compared with Slowinske's (Du Pont's) rain tester (presumably the same as the A A T C C Rain Tester; see the *1951 AATCC Technical Manual and Year Book*, p 136). The sensitivity of the penetration tests is very low compared with the absorption tests. The two former tests rank the fabrics in about the same order. The author suggests that when fabrics with plain surface are tested, Slowinske's rain tester will give valuable information, especially when very good fabrics are to be compared. For fabrics with a compressible or raised surface, however, a rain tester with lower drop intensity should be preferred. The basis for comparison of rain-resistant fabrics is discussed.

Peroxide Damage

C H Bayley, Canadian Research Inst of Launderers & Cleaners, *Textile J Australia* 26, 1112, 1114, January, 1952.

Hydrogen peroxide is a common article for both cosmetic and medicinal use, but it is doubtful if many realize that it can cause severe chemical damage as well as color damage in fabrics.

When allowed to come in contact with cellulosic fabrics, e g, cotton, linen, rayon, especially in concentrated form, it produces oxycellulose with a consequent weakening of the fabric. A secondary damaging effect which may result from contact with hydrogen peroxide is due to the presence in it of a small quantity of mineral acid added to increase the stability of the peroxide and prevent it from losing its oxygen during storage. The amount of acid present, although small, is sufficient to damage many textile fibers, e g, cotton, linen, rayon, nylon, and this is especially true when fabrics containing such fibers are wetted with a solution of peroxide and allowed to dry without rinsing. Under these conditions the originally dilute acid becomes concentrated in the fibers with resultant chemical tendering.

In addition to tendering, we frequently

see cases of dye damage around the neckline of blouses, dresses, suits, housecoats, etc, caused by contact with peroxide which has dripped from the hair during a "brightening" (bleaching) treatment at a beauty parlor or in the home.

In the above types of damage, the full extent of the injury frequently does not become apparent until the fabrics have been laundered or cleaned, since, where fabric tendering has occurred, the mechanical action of the laundering or cleaning process may cause holes to develop in the already-weakened fabric; the dyes in those areas which have come in contact with peroxide during use frequently show an increased solubility in laundering solutions or intensified color change in dry cleaning, although we have seen cases where the discoloration became obvious prior to dry cleaning or laundering.

The information given above should not be taken to mean that all cases of color damage in neckline area are due to peroxide, for cold-wave solutions are actually a more frequent cause. However, discoloration caused by cold-wave solutions can generally be identified by the medicinal type odor given off when the affected area is wetted, and they also give distinctive chemical reactions in the laboratory if the damaged areas have not previously been given too thorough spot removal treatment.

Outstanding and Deficient Properties of Some Common Textile Fiber Materials

W F Luther, from article on "A Functional Approach to Blending", *Rayon & Synthetic Textiles* 33, No 2, 52, February, 1952.

Outstanding Properties

Cotton: Inexpensive, good wet and dry strength, simple launderability, high absorbency, good heat and ironing resistance, easy dyeing.

Wool: High elongation, high elastic recovery, warmth, felting power, high moisture absorbency.

Silk: High strength, high pleasant luster, high elasticity, good moisture absorbency, pleasant hand.

Viscose Rayon: Inexpensive, high flexibility, good draping qualities, high moisture absorption and production with controlled size, luster, crimp, strength, etc.

Acetate Rayon: Good draping qualities, pleasant hand, pleasant luster, quick drying.

Nylon: High abrasion resistance, high tensile strength, quick drying, easily dyed.

Orlon: Outstanding weathering resistance, good tensile strength, quick drying.

Dacron: Low flexibility, high elastic recovery, low moisture absorption, good wrinkle resistance.

Dynel: Doesn't burn, resistance to acids and alkalis, wrinkle resistance, compressional resilience and soft warm hand.

Fiberglas: Doesn't burn, extremely strong, good electrical resistance.

Vicara: High moisture absorption, high elastic recovery, easily dyed, good hand.

Deficient Properties

Cotton: Draping, wrinkling, soiling, variation from crop to crop.

Wool: Attacked by moths, shrinks when wet, widely fluctuating price.

Silk: Uncertain supply and price.

Viscose Rayon: Weak when wet, low laundry life, musses easily.

Acetate Rayon: Sensitive to heat, low strength, doesn't launder well.

Nylon: Low elastic recovery, yellows on heating, produces static charge, pills in spun goods.

Orlon: Hard to dye, unavailable in bleached form, produces static charges in processing and wearing.

Dacron: Hard to dye, produces static charges.

Dynel: Unusually low ironing temperature required, produces static charges, unavailable in bleached form.

Fiberglas: Difficult to dye.

Vicara: Weak when wet, does not spin 100 per cent.

Copper 3-Phenyl Salicylate—a Textile Preservative

E E Perrin, *Rayon & Synthetic Textiles* 33, No 4, 78, 80, April, 1952.

Recent tests by the Dow Chemical Co and other industrial laboratories have demonstrated that copper 3-phenyl salicylate is a nonirritating, nonsensitizing fungicide and bactericide. It has been approved by the U S Government for use on duck and twill, for which purpose 1.25 plus or minus 0.25 per cent of material on the weight of the fabric is specified.

Tests indicate that the compound should prove important as a preservative for tents, tarpaulins, and other outdoor canvas and duck equipment.

Laboratory and field tests have shown that copper 3-phenyl salicylate effectively controls the organism causing the rotting of cotton fabric and the growth of mildew on the fabric. Outdoor exposure in southern Louisiana for six months of treated cotton fabric developed no mold growth, and soil burial tests proved that this treatment effectively protects the fabric from rotting.

Copper 3-phenyl salicylate may be dissolved in a mixture of organic solvents. The goods are passed through this solution, squeezed, and dried. The material may also be easily applied as a dispersion in water. The following formulation is suggested:

Copper 3-phenyl salicylate...	50 parts
Metnocel, 1500 cps.....	2 parts
Triton X-100	2 parts
Cold water	112 parts

This mixture is ground to a smooth dispersion in a ball mill, homogenizer, or colloid mill, and applied to the fabric by padding and drying.

Copper 3-phenyl salicylate may also be produced on the fabric by a two-bath process. The goods are first padded through a water solution of sodium 3-phenyl salicylate and then through a water solution of copper acetate.

The effectiveness of copper 3-phenyl salicylate can be prolonged by the use of certain resinous binders, or by water-repellent treatment.

Resin Finishes and Textiles: Control of Deposition

Anon, *Textile Inds & Fibres* 13, 236, July, 1952.

In the application of resin finishes to textile materials it is important to be able to control the deposition of the resin, for it makes considerable difference to the finish obtained whether most of the resin is inside the fibers or is deposited outside of them. Experience in the application of urea and melamine-formaldehyde resins for the purpose of securing crease-resistance or dimensional stability has consistently shown that while simple deposition of such resins within or outside the fibers confers some degree of stiffness, this effect of the resin deposited on the outside is very much greater. Thus, except in those instances where stiffness is desired, it is usual to control the resin treatment so that almost all the resin is left within the fibers. A light after-soaping may be required to ensure this by removing loose superficially deposited resin. Staining techniques are the most convenient means for ascertaining how the resin has been deposited.

The following acid dyes have been employed for this purpose:

Kiton Blue V
Disulphine Blue VNS
Anthraquinone Blue BN
Benzyl Red B

These dyes leave cellulose colorless while they stain the resin both on the surface and on the interior of the fiber.

Another staining method makes use of an alkaline silver nitrate solution instead of a dye. In this test the presence and distribution of the resin are indicated by a brown stain. Critics of this test claim that it does not show the distribution of the resin inside and outside of the fiber as well as the test using acid dyes. However, the silver nitrate method is generally useful for indicating the amount of resin present in textile fibers, for the depth of stain is roughly proportional to the amount of resin present.

Proceedings of the
American Association of Textile Chemists and Colorists

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Editor of Proceedings: Carl Z Draves, 30 Lahey St, New Hyde Park, N Y

September 1, 1952

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CALENDAR

COUNCIL
September 12 (Philadelphia); November 6 (Boston), Jan 16, 1953; April 17, 1953; June 5, 1953.

GENERAL RESEARCH COMMITTEE
(See Council dates)

NATIONAL CONVENTIONS
November 6-8, 1952 (Hotel Statler, Boston); September 17-19, 1953 (Hotel Conrad Hilton, Chicago); 1954 (Atlanta, Ga.); Sept 21-25, 1955 (Chalfonte-Haddon Hall, Atlantic City, N J).

MID-WEST SECTION
October 4, February 14 (Hotel Bismarck, Chicago, Ill); April 18 (Netherland Plaza, Cincinnati, O); June 20 (Outing, Lake Delavan, Wis); November 7, 1952 (Hotel Bismarck).

NEW YORK SECTION
September 26, October 24, November 21 (Kohler's Swiss Chalet, Rochelle Park, N J); January 30, February 27 (Hotel Statler, New York, N Y); April 17, May 22 (Swiss Chalet)

NORTHERN NEW ENGLAND SECTION
December 6 (Annual Meeting, Lowell Textile Institute).

PACIFIC SOUTHWEST SECTION
October 4 (Outing, Ojai, California).

PHILADELPHIA SECTION
Sept 12, Oct 24 (Penn Sheraton Hotel); Dec 5, Jan 16 (Kugler's Restaurant).

PIEDMONT SECTION
Sept 13 (Hotel Charlotte, Charlotte, N C).

RHODE ISLAND SECTION
Oct 24 (Providence Engineering Society); December 5 (Annual Meeting, Sheraton-Biltmore, Providence, R I).

SOUTH CENTRAL SECTION
December 6 (Patten Hotel).

SOUTHEASTERN SECTION
Sept 13 (Biltmore Hotel, Atlanta).

WESTERN NEW ENGLAND SECTION
Oct 3, Nov 14 and Dec 12 (Rapp's Restaurant, Shelton, Conn).

OTHER EVENTS

AMERICAN CHEMICAL SOCIETY

7th National Chemical Exposition, Sept 9-13, Chicago Coliseum, Chicago, Ill. This will include the 2nd International Art Exhibit.

AMERICAN SOCIETY FOR TESTING MATERIALS

1953 Annual Meeting, June 29-July 3, Chalfonte-Haddon Hall, Atlantic City, N J.

AMERICAN STANDARDS ASSOCIATION

3rd National Standardization Conference, Sept 8-10, Museum of Science and Industry, Chicago, Ill.

34th Annual Meeting, November 19, Waldorf-Astoria, New York, N Y.

AMERICAN TEXTILE MACHINERY ASSOCIATION

Exhibit of American Textile Machinery, April 26-May 1, 1954, Atlantic City Exhibition Hall, Atlantic City, N J.

CANADIAN TEXTILE SEMINAR

September 11-13, Queen's University, Kingston, Ont.

FIBER SOCIETY

Sept 10-11 (Princeton, N J).

INTERNATIONAL COTTON AND RAYON EXHIBITION

Sept 27-Oct 12, Busto Arsizio, Italy.

LEIPZIG FAIR

September 7-17, Leipzig, Germany.

NATIONAL ASSOCIATION OF HOSIERY MANUFACTURERS

41st Knitting Arts Exhibition, April 27-May 1, 1953, Atlantic City Auditorium, Atlantic City, N J.

NEW YORK BOARD OF TRADE (DCAT)

26th Annual Meeting: September 25-28, Pocono Manor Inn, Pocono Manor, Pa.

27th Annual Drug, Chemical and Allied Trades Dinner, March 5 (1953), Waldorf-Astoria, New York, N Y.

TEXTILE RESEARCH INSTITUTE

23rd Annual Meeting, Nov. 17-18, Hotel Commodore, New York, N. Y.

EMPLOYMENT REGISTER

This column is open for two insertions per year, per member, without charge. Blanks can be obtained from, and filed with, the Secretary of the Association, Lowell Textile Institute, Lowell, Mass. It is understood that these will be open to inspection by prospective employers who can obtain further information from the Secretary.

8-18

52-17

Education: Lowell Evening Textile School and university extension.
Experience: assistant dyer, wool.
Age: 25; single; references; northeast U S preferred, but not essential.

8-18, 9-1

52-18

Education, College (evening), chemistry.
Experience: chemist, laboratory head, plant manager.
Age: 30; married, references; New York or northeast U S preferred.

8-18, 9-1

52-19

Education: A B, organic chemistry, followed by textile school.
Experience: Two years as chemist in product development.
Age: 29; married; references; vicinity of Philadelphia preferred.

9-1, 9-15

Change in Philadelphia Section Program

JOSEPH W MacNEIL, Publicity Chairman, Philadelphia Section, has announced a change in the Section's September 12th program. In place of a film on test methods by the J C Penney Company, Proctor and Schwartz, Inc will present a new color and sound motion picture on the Redman Process for control of relaxation shrinkage in tubular knit fabrics.

Two showings will be given at 6:30 pm and 6:45 pm in the Della Robbia Room of the Penn-Sheraton Hotel, Philadelphia.

Southeastern Section to Meet Sept 13

THE Fall Meeting of the Southeastern Section, to be held September 13th in the Pompeian Room of the Biltmore Hotel, Atlanta, Ga, will feature an afternoon technical session and an evening banquet session.

The technical session is scheduled for 3:00 pm. J H Stradley, E I du Pont de Nemours & Co, Inc, will discuss "Recent Developments in Beam Dyeing Techniques," after which Dr A K Saville, of Du Pont's Technical Laboratory, will speak on "New Printing Techniques."

The evening session will feature R K Mason, manager in charge of construction at the Savannah River Plant, who will speak on "The Savannah River Plant—A Construction Challenge."

Guests are invited.

REPORT OF THE NOMINATING COMMITTEE

THE Councilors representing Sections, in their capacity as Nominating Committee, have nominated J Robert Bonnar and Raymond W Jacoby for President in the year 1952. Mr Rabold's permitted term of office, under the Constitution, expires within the current year. The nomination of any other Senior member, signed by fifty or more Senior members, may be filed with the Secretary not later than October 1st, and will be given equal standing on the ballot.

The members of the Northern New England, Rhode Island and Western New England Sections will elect a Vice-President for the New England Region. The Councilors from this Region have nominated George O Linberg.

The members of the Hudson-Mohawk, New York and Philadelphia Sections will elect a Vice-President for the Central Atlantic Region. The Councilors from this Region have nominated George L Baxter and Arthur W Etchells.

The members of the Piedmont, Southeastern and South Central Sections will elect a Vice-President for the Southern Region. The Councilors from this Region have nominated Samuel L Hayes.

The members of the Mid-West, Pacific Northwest and Pacific Southwest Sections will elect a Vice-President for the Western Region. The Councilors from this Region have nominated Arthur T Brainerd.

A nomination for Vice-President from any Region, signed by twenty-five or more Senior members of that Region, may be filed with the Secretary not later than October 1st, and will receive equal standing on the ballot with other nominations for that office.

This report is published to comply with Article VI, Section 1, of the Constitution regarding date of publication. Other nominations will be published at the earliest possible date following receipt of each.

HAROLD C CHAPIN, *Secretary*

AATCC STREAM POLLUTION COMMITTEE BULLETIN

TRAINING courses on the analysis of polluted waters, industrial wastes, and abatement of stream pollution will be given at the Environmental Health Center, laboratories of the Public Health Service in Cincinnati, Ohio, during the coming Fall, Winter, and Spring. Although intended mainly for professional personnel from state and local health departments and other governmental units, the courses are also open to industrial representatives who are cooperating with these agencies on stream sanitation problems.

Technical personnel of the EHC staff carry on researches, field investigations, and training activities related to abatement of water pollution, treatment of water, sewage and industrial waste, atmospheric pollution, and radiological health. These activities form a foundation for the training program, with attendance of industrial representatives being encouraged by the National Technical Task Committee on Industrial Wastes.

Information on the courses which may be of interest to the textile mill operators are summarized below:

1. EXAMINATION OF POLLUTED WATERS AND INDUSTRIAL WASTE

   Date: October 13-24, 1952

   Subject Matter: A two-week training in the methods and techniques used in water pollution and industrial waste surveys, including:

   a) methods of investigating industrial waste problems
   b) statistical methods applied to stream pollution data
   c) latest chemical, biological, and bacteriological test techniques for use in water pollution abatement programs
   d) interpretation of water pollution data
   e) water quality objectives
   f) correction of water pollution problems

   Entrance requirements: Candidates should be college graduates in chemistry, biology, or bacteriology, and need have little or no experience in water pollution and industrial waste survey methods.

2. ADVANCED TRAINING FOR SANITARY ENGINEERS IN WATER POLLUTION ABATEMENT PROGRAM

   Date: March 2-13, 1953

   Subject Matter: Two-week training with emphasis on the administration of stream pollution programs and interpretation of data. The course material covers areas similar to the above, but on a broader basis and more advanced level.

   Entrance requirements: Candidates should be graduate engineers with wide background in water pollution control.

Letters of application for the training courses should be sent to:

Officer in Charge
Environmental Health Center
1014 Broadway
Cincinnati 2, Ohio

and should include a brief outline of the education and experience of each candidate. Personnel from organizations other than health departments should be recommended by the division heads of their respective sponsoring organizations. Applications should be received at the Environmental Health Center six weeks before the starting date of the course.

No tuition will be charged for this course. Trainees are expected to arrange means for their own living and travelling expenses connected with the course. Hotel reservations will be made for accepted applicants upon their request.

PRELIMINARY NOTICE

1952 CONVENTION

American Association of Textile Chemists and Colorists

Auspices of THE NORTHERN NEW ENGLAND SECTION

Hotel Statler, Boston, Mass. • November 6, 7, 8, 1952

America Advances Through Creative Chemistry

THE Northern New England Section extends an invitation to come to Boston for the 1952 National Convention, to be held November 6, 7, and 8, 1952, at the Hotel Statler.

For comfort and convenience, technical paper sessions will be held in the main ballroom.

All exhibits are on one floor.

A luncheon for the Olney Medal Award with the Student's Prize Paper Award on Friday, and an Alumni Luncheon on Saturday, will precede the Annual Banquet on Saturday evening.

PROGRAM

Thursday, November 6

Morning: Council Meeting
Student Chapter Prize Paper Contest
Afternoon: Technical Session
Evening: No Formal Program

Friday, November 7

Morning: Two Technical Sessions
Luncheon: Olney Medal Award
Afternoon: Technical Session
Evening: Concert by The Boston Pops Orchestra

Saturday, November 8

Mornings: Intersectional Prize Paper Contest
Luncheon: Textile Schools Alumni
Afternoon: No Formal Program
Evening: Annual Banquet

EXHIBITS

The exhibits in the Georgian Room and Parlors on the Hotel Statler Mezzanine will be fine examples of this year's slogan "America Advances Through Creative Chemistry."

The textile and associated industries display the ever-increasing advance in fibers, chemicals and processing machinery. These new advances are the results of continuing expansion of research facilities available to the industry.

The AATCC Research Committee Exhibit stimulates thought and recalls the continuing contributions made by our organization in its thirty-one years to an industry which appreciates its reliance on aggressive colorists and chemists for good competitive positions.

PERSONNEL SERVICE

For the purpose of introducing members to employers, Personnel Service will operate, without charge, from Thursday afternoon, November 6th, through Saturday morning, November 8th. Members seeking employment should, if possible, register before the convention; but members, as well as employers, may register at the convention.

HOTEL RESERVATIONS

Adequate hotel accommodations in Boston at the Hotel Statler, Parker House, Hotel Touraine, Sheraton Plaza and Hotel Bradford will be available. Reservations may be made *ONLY* through the Registration Committee and applications for hotel rooms will be sent the membership about the middle of September. Hotel Reservation Cards should be returned at once with the registration envelope.

LADIES' ENTERTAINMENT

A special program is being planned for the entertainment of the ladies attending the Convention, the details of which will be announced later. The regular technical sessions will be open to those ladies who wish to attend them.

ENTERTAINMENT

On Friday evening, November 7th, in the Statler's Main Ballroom, there will be a Concert by the famous Boston Pops Orchestra under the leadership of Arthur Fiedler. Your registration fee will include a free ticket to this event.

TRANSPORTATION

The Transportation Committee feels that members will find no difficulty in getting to and from the Convention in Boston. Good train service from points south, west and north are available as well as plane service. All railroad and airlines will be notified for possible increases in reservations at the time of the convention so that accommodations will be available.

FINAL NOTICE

The final notice containing complete details of registration, hotel reservations, dinner and luncheon tickets, ladies' program and entertainment will be sent shortly.

IMPORTANT NOTICE

To all manufacturers of Textile Chemical Specialties:

The American Association of Textile Chemists and Colorists is now collecting material for the 1953 Edition of its *Technical Manual and Year Book*, and solicits your co-operation.

With respect to the list of Textile Chemical Specialties, in response to many requests, the Publications Committee has decided to resume the annual revision of this list, as conducted in the past. All manufacturers and importers of textile chemical specialty products are therefore invited to submit data for the 1953 Edition, covering the following items only:

New data not previously listed
Correction of errors
Deletion of obsolete products

Cards should be filled out strictly in accordance with the directions accompanying this notice, and following the style of presentation employed in the 1952 Edition. All cards should be mailed before December 1, 1952, to the undersigned, who succeeds Dr. Carl Z. Draves as editor of this section.

WILLIAM H CADY, Editor
Technical Manual and Year Book
127 Power Street
Providence 6, Rhode Island

September 1, 1952.

DIRECTIONS FOR FILLING OUT CARDS

IN the compilation of this list of American sources of textile chemical specialties, products are selected primarily for their specific usefulness in textile processing, but because some textile chemicals, such as the surface-active agents, are employed in other industries, nontextile uses are permitted to be indicated.

The reader should bear in mind that information from firms concerning uses and compositions is repeated without investigation and thus cannot be vouched for by the Publications Committee. However, all data received will be carefully edited and any exaggerated claims will be eliminated.

Information for new products should be tabulated on 3 x 5-inch cards as described below. Where it is desired to make corrections in old entries in either the Index or the Alphabetical List, or to make deletions of old entries for withdrawn products from both these, new cards should be prepared in the same manner appropriately marked for correction or for deletion, respectively, as described in these directions. Do not prepare cards for products already properly indexed and listed.

I. Key
- (a) On first line: firm abbreviation, limited to five letters.
- (b) On third line: firm name.
- (c) On fourth and fifth lines: firm address.

II. Index
- (a) on first line: index heading, selected only from those of Part II for *every* use of a product. If a product has more than one use and therefore needs to be listed under more than one heading, make out a separate card for each use heading in Part II.
- (b) On third line, toward left: name of only *one* product, without any descriptive letters.
- (c) On third line, toward right: abbreviation or firm name as given in Part I.
- (d) On bottom line: indicate if card is a New Index Entry, or a Corrected Index Entry, or a Deleted Index Entry.

III. Alphabetical List
- (a) On first line: abbreviation of firm name.
- (b) On third line: complete proprietary name of product with descriptive letters; if name of product is a registered trade-mark, indicate the fact by an asterisk following the registered part of the name.
- (c) On fifth line: uses (e.g., detergent, softening, etc.) or uses for certain specific purposes.
- (d) On eighth line: chemical nature, adequately given.
- (e) On tenth line: patent number, if product is patented.
- (f) On bottom line: indicate if card is a New List Entry, or a Corrected List Entry or a Deleted List Entry for a discontinued product.

In making out the cards described above, it is necessary that you make them out exactly as requested, including the style of presentation followed in the List itself, or they will be returned for improvement. The following points are to be observed: that the names of products are written in small letters, except for the initial letters; that periods are not placed after names of products, after firm abbreviations, after uses or after chemical natures; that semicolons are used to separate uses; that degrees of quality are not permitted under uses; and that the international method of naming chemicals is employed under chemical nature.

Cards containing information about textile chemical specialties for the 1953 *Technical Manual and Year Book* must be received before December 1, 1952, to meet editorial schedules.

Southeastern Section——

STABILIZATION AND SHRINKAGE CONTROL*

W A WARDELL
Rohm and Haas Co.

A pioneer in the field of marketing resin finishing agents explains how shrinkage control and fabric stabilization were developed as important by-products of crush resistance. He then goes on to discuss textile-finishing processes and especially the effect of each on dimensional changes. By means of a large table he shows how each finishing process affects the many properties of dyed and finished materials of natural, man-made and synthetic fibers. The most important feature of the paper is a discussion of just how various resin finishes can be employed to obtain the balance of dimensional stability, handle, crush resistance and other properties that are important for the sale and use of textiles.

INTRODUCTION

Because of the breadth of the subject matter and the time alloted for its discussion, I will limit myself to the stabilization and shrinkage control of cellulose fabrics and mixtures of high-cellulose content. Also, because of limited time and recent up-to-date coverage of crush resistance, I will only mention crush resistance from time to time in connection with shrinkage control.

When John Mercer invented mercerizing back in 1844, he did not discover an important result, shrinkage control, nor was it, to my knowledge, mentioned in literature until Sanforizing was invented and promoted in 1930, almost a century later. Then it was noted that mercerized fabrics shrank less than unmercerized fabrics.

When Tootal, Broadhurst, and Lee discovered a process for crush resistance based on synthetic resins back in 1929, they quickly promoted the process. However, they did not emphasize the fact that dimensional stabilization was obtained as a by-product of the crease resistant process. It might interest you people here to know that right in this area Kemp Haynes and I learned, in 1937, that urea-formaldehyde resins could be used to obtain shrinkage control. This observation was made during plant trials made at the Lanett Bleachery on a Callaway Mills cotton gabardine to produce a Sanforized, crush resistant fabric. A second trial confirmed the first and quickly resulted in volume business for synthetic resins in textile processing and an immediate widespread interest in the use of such resins for stabilization and shrinkage control followed. It was the push that the crush-resistant process needed.

I know of no other textile process which started from scratch one month and skyrocketed to volume business the very next month, or which has saved as many yards of textile fabrics. It was my good fortune to go before the War Production Board in Washington during the early part of World War II to show this Board that the use of synthetic resins through stabilizing shrinkage made available more yards for a critical civilian shortage of fabrics.

When shrinkage is mentioned, I always remember the young "eager beaver" from the piney woods of Georgia who came to a North Carolina finishing plant. He was started out as a sweeper, as was the custom for a college graduate back in those days. He had been sweeping a week when we ran short of a man on the Sanforizers, and therefore he was promoted to box pusher and in addition was given the job of measuring yard marks before and after Sanforizing. For a couple of weeks, he put yard marks on the cloth, which would measure about 34 inches after Sanforizing, and each time he would shake his head in amazement. Finally, he remarked, "I don't want to appear dumb, but where in the hell is that two inches of cloth going?"

To give you some idea of the tremendous growth in shrinkage control and stabilization and the more tremendous introduction of new products, I will make a few short quotations from previous talks I have given on the subject and refer you to other records. I quote from a talk which I gave at our annual sales meeting in 1937: "Today there are two distinct attempts being made to reduce shrinkage in fabrics. The older and more commonly known is a mechanical process called Sanforizing. The other is a recently developed chemical method with urea-formaldehyde resins." In this same paper I made this comment, "We must realize that all chemical manufacturers of resins will enter this field, though we have no competition today. If we are to hold our position in this field we have pioneered, we must always keep ahead. Our customers will be asking for a product that will set shrinkage under ordinary plant conditions with no curing and no after-treatment".

Now I would like to refer you to some figures. In the *AATCC 1937 Year Book* only one chemical process was offered for stabilization: namely, Rhoflaxes. And, in the *1938 Year Book*, only two additional products were mentioned: namely, Rhonites and Rhoplexes.

I quote again from an article *(1)* I wrote for *Cotton Magazine* in July, 1940: "While there has been a tremendous improvement in the yarns and fibers used in the manufacture of spun-rayon fabrics, particularly with the new high-strength filaments, there is still need for further improvement in finishing spun rayons. "There is a definite trend toward the production of high-quality spun-rayon fabrics with the fastest of colors and with the fastest of finishes. There is an increasing demand for washable fabrics which do not shrink or stretch and which will hold their character and hand with continued use. The application of permanent finishes and fast colors is making possible the production of a line of spun-rayon fabrics which will increase in demand and popularity and which will compete with the finest of worsteds and woolens. There is every reason to believe that the spun-rayon fabrics of tomorrow will be the best buy the consumer has yet obtained in high-grade and serviceable textiles."

Now, to give you some idea of the magnitude of what has happened in textile finishing and in chemical manufacturing since 1937, I refer you to the September 6, 1951 issue of the *Daily News Record*. This issue gives tables with at least one trade name for every letter in the alphabet except "J" and "Y" for either a chemical product offered by a chemical manufacturer or a trade name offered by the mills based on crease resistance, shrinkage control or stretch and sag resistance. Actually, this issue of the *Daily News Record* lists approximately seventy-three different chemicals recommend for either crease resistance, shrinkage resistance, or

* Presented before the Southeastern Section in La Grange. Ga, on December 8, 1951.

stretch and sag resistance, and lists about ninety-six trade names from the various finishing mills, based on crease resistance, shrinkage control and stretch and sag resistance. In addition, there are many more finishing plants using chemicals for stabilization and shrinkage control who have not established trade names. This field is literally covered from A to Z, from Aerotex to Zeset, with all manner of "sets" in between.

SELECTION OF RESIN FINISHES

Now, to get down to brass tacks and the layman's point of view, let us see what some of these processes will do. I have outlined in Table I a classification of the various processes.

The manufacture of synthetic yarns, such as Orlon, that have a minimum of shrinkage cannot be classed as a stabilizing process from the finisher's standpoint, but it is mentioned to show the trend of improved stabilization from the yarn manufacturer. Note this step from resin-treated cellulose fabrics to fabrics made of resin yarn. Perhaps within the foreseeable future, we will be offering cellulose chemicals for treating resin fabrics.

Little more will be said about wet cross-linking processes, since these processes are still laboratory curiosities, which have not been thoroughly tested in the field.

From Tables I and II, we should be able to pick out a practical stabilizing process to fit the requirements of any particular fabric with definite advantages and with a minimum of disadvantages.

It is a well established fact that mechanical shrinkage alone is not satisfactory for rayons, and a setting process is required.

If crush resistance is desired, then we would necessarily have to pick from thermosetting resins and cellulose reactants. If chlorine retention is not a particular drawback, as is the case of all fabrics dyed with direct colors, we would more than likely choose urea-formaldehyde resins because of lower cost. If we still want crush resistance and a minimum of chlorine retention, we might choose a crush-resistant reactant resin. If we have a mixed-cellulose fabric high in wool content, we would consider melamines as they are claimed to be more effective for shrinkage control of wool than other known types.

Shrinkage control with maximum added weight would call for either monomeric urea-formaldehyde resins or monomeric melamine-formaldehyde resins with perhaps small amounts of partially polymerized thermosetting resins, thermoplastic resins, or cellulose ethers to obtain the desired firmness. Stabilization with maximum crush resistance and minimum added weight would call for the reactant types, and here consideration would be given not only to cost but to the effect on physical properties and on the ease of control of the process.

TABLE I

STABILIZING PROCESSES

I Caustic treatments
  1) Mercerizing
  2) Causticizing
II Mechanical shrinkage control
  1) Sanforizing
  2) Slack drying
  3) Tensioning beyond strain point
III Fiber-bonding treatments
  1) Alkali-soluble hydroxyethylcellulose
  2) Rubber latex
IV Cellulose solvents
  1) Sulfuric acid
  2) Cuprammonium hydroxide
V Thermosetting resins
  1) Urea-formaldehyde
  2) Melamine-formaldehyde
  3) Ketone aldehyde
  4) Acid colloid
VI Cellulose reactants
  1) Formaldehyde
  2) Glyoxal
  3) Modified urea-formaldehyde (as Rhonite R-1)
VII Thermoplastic resins
  1) Acrylic
  2) Vinyl
  3) Styrene
  4) Butadiene
VIII Heat setting (as for nylon and Dacron polyester fiber)
IX Manufacture of yarns and fabrics that do not shrink (such as Orlon acrylic fiber)
X Wet cross-linking, such as divinylsulfone applied in aqueous solution in the presence of a catalyst

If we want permanent deep luster (on cottons), we would mercerize, and if we want permanent surface luster, we would choose from urea-formaldehyde resins, melamines or modified urea-formaldehyde reactants or a combination of any of these.

If we want firmness without crush resistance, we would choose among partially polymerized urea-formaldehyde resins, acid colloids, or a combination of reactants with thermosetting resins or cellulose ethers. If we want softness without crush resistance, we might consider the noncrush-resistant cross-linking compounds.

To stabilize cotton napkins and tablecloth to a linen-like hand and good laundry appearance, one of the bonding processes, such as alkali-soluble hydroxyethylcellulose, would be given prime consideration.

For preventing thread slippage and distortion of some upholstery and drapery fabrics where only the face shows, rubber-latex bonding by the back-coating method of application is recommended.

Cellulose solvents, either sulfuric acid or cuprammonium hydroxide, are effective for producing a stabilized crisp hand for cotton marquisettes and other sheer fabrics.

If we want maximum physical properties with good stabilization against shrinkage and stretch, we would combine one of the setting processes with a mechanical shrinkage process. Speaking of mechanical processes, in addition to Sanforizing and slack drying, I mentioned in the outline tensioning beyond strain point. This method, by which a cotton fabric is sometimes wet out and frame-dried considerably beyond grey width, gives a wider wash width. This method is recommended only for cotton fabrics and occasionally for nylon fabrics during the heat-setting process.

Now let us get down to a practical case and assume that you have a cotton chambray on which you want maximum stabilization with good crush resistance and you picked from the table the modified urea-formaldehyde reactant type. Initial trials are made and you get good stabilization and crush resistance, but the finished fabric has the following disadvantages:

1) Odor.
2) Tear strength too low.
3) Wash width one-half inch too narrow.
4) Needle cutting during sewing.
5) Shrinkage control not sufficiently permanent.
6) Hand too soft.
7) Not enough luster.

With as many disadvantages showing up from your initial trial, you are apt to throw up your hands and say, "it can't be done", but let us now analyze our problem and see what improvements can be made. As for the odor, you may have used an ammonium catalyst, which reacted with formaldehyde to produce a methylamine salt, and this salt, with overcuring and possibly with alkali left in the fabric following the afterwash, disassociated and gave off a methylamine odor. This condition may be corrected by substituting a weak acid catalyst, such as an amine hydrochloride or a complex amine salt, which is free of ammonium ions, plus a more thorough afterwash and rinse. Actually, methylamine is very water-soluble and any such odor formed during processing will readily wash out in a thorough afterwash, followed by rinsing.

Low tear strength and needle cutting may go hand in hand with lack of, or with insufficient, lubrication. This may be improved greatly with a selected alkyd

TABLE II

EFFECTS OF STABILIZING PROCESSES ON TEXTILE PROPERTIES

EFFECTS	STABILIZING PROCESSES														
	Mercerization	Causticization	Sanforizing	Use of cellulose solvents	Urea-form resin	Melamine-form resin	Ketone-aldehyde resin	Acid colloid resin	Thermoplastic resin	Alkali-soluble HEC	Rubber latex	Glyoxal	Formaldehyde	Modified urea-form resin	Heat setting
Shrinkage production	+	2+	2+	+	0	0	0	0	0	0	0	0	0	0	0
Shrink setting	+	+	0		2+	2+	+	+	0	0	0	3+	3+	3+	+
Stretch setting	+	+	0	+	2+	2+	2+	2+	+	+	+	2+	2+	2+	0
Crease recovery	0	0	0	—	2+	2+	+	0	—	—	—	0	+	+	0
Thread-slip resistance			0		+	+	+	+	+	+	+				0
Bacterial resistance	0	0	0	0	+	+	+	+				+	+	+	0
Insect resistance	0	0	0	0	+	+	+							+	0
Dye washfastness			0		+	+	+						+	+	0
Ease of removal	0	0	+	0	+	0	+		0	0	0	0	0	+	+
Tear strength			+	2—	2—	2—	2—	—	+		+	2—	2—	2—	0
Cotton breaking strength	+	+	+	—	—	—	—	—	+		+	—	—	—	0
Rayon breaking strength			+						+		+	2—	2—	—	0
Wet-abrasion resistance					+	+	+	+				+	+	+	0
Dry-abrasion resistance					—	—	—		+			—	—	—	0
Cure	0	0	0	0	2+	2+	2+	+	0	0	0	2+	2+	2+	0
Afterwash	+	+	0	+	+	+	+	+	0	+	0	+	+	+	0
Iron pickup	0	0	0	0	0	+		+	0	0	0		0	0	0
Chlorine retention	0	0	0	0	2+	2+		2+	0	0	0	0		+	0
Relative cost	+	+	+	2+	+	2+	+	2+	+	+	+	+	+	+	+
Direct-dye lightfastness			0		*	*	—	2—	0		0	2—	2—	2—	0
Vat-dye lightfastness	0	0	0		0	—		—	0	0	0			0	0
Wool-mixture stabilization	0	0	+	0	+	2+			+	0	+		+	+	0
Acetate-mixture stabilization	0	0	+	0	+	+	+	+	+	0	+		+	+	0
Nylon-mixture stabilization			+	+	+	+	+	+	+		+		+	+	
Nylon stabilization	0	0	0	0					+						+
Improvement of handle	+	+	0	+	+	+	+	+	+	+	+	0	0	0	0
Ease of control	+	0	+	0	+	+			+	+	+	0	0	+	+
Wash fastness	+	+	+	+	+	+	+	+	+	+	+	2+	+	2+	+

KEY

Increase in effect: +, distinct; 2+, appreciable; 3+, much
Decrease in effect: —, distinct; 2—, appreciable; 3—, much
No effect: 0
No information available: blank space
Light fastness decreased for some dyes, but not all: *

softener or with a permanent-type water repellent. Again, this low tear might be due to overcure, and in that case may be improved somewhat by lowering the curing temperature and increasing the curing time.

The narrow wash width may be corrected by drying after impregnation at an approximately one-inch-wider width. However, if the fabric has already been dried at the maximum width and this is a mercerized fabric, it may be necessary to mercerize at a wider width.

Lack of sufficient permanency of shrinkage control might be traced back to lack of sufficient desizing and scouring, to lack of sufficient penetration of the resin, to alkalinity of the fabric previous to treatment, or to insufficient cure. Your problem of permanency might therefore be solved by correcting one or more of these conditions.

If the hand is too soft and if you want to maintain minimum chlorine retention, you would consider adding a thermoplastic resin or a cellulose ether for building up the hand.

To increase luster, you can choose between premercerizing for deep luster and calendering between drying and curing for surface luster.

Let us assume for another problem that your customer has a 50-50, spun-acetate-spun-rayon blend dyed with direct and acetate dyes on which he requests maximum crush resistance and shrinkage under 2% with a soft, full hand. Looking over Table II, you decide to use monomeric urea-formaldehyde resins, and, with 8% solids in the fabric, you are able to make your customer happy with an extra bargain of shrinkage below 1%. He accepts this finish for over a year with frequent favorable comments. This perhaps happens during a shortage of fabrics.

Then the market begins to break, and he sends back a coat made of this fabric, which he claims shows considerable fading, and he further claims a farmer wore this coat to the fields one hot summer day to plant his cotton. Imagine a cotton farmer wearing a coat made of synthetic yarn. Well, the sun begins to bear down, and he takes off his coat and lays it on a stump, where he discovers it again at cotton-picking time. Of course, the farmer wants his money back, and your customer wants you to settle the claim, to improve lightfastness and to cut finishing prices. You call in your chemist and he finds that the resin decreases the lightfastness of two of the colors, and the third color had poor lightfastness to begin with. Anyway, the chemist finds better substitutes for two of the dyes, which resins do not affect, and adds a little chromium acetate or copper sulfate to improve the lightfastness of the third dye, and your customer is happy again.

Things go along very quietly for a time, and then the market changes again and your customer writes saying, "hand does not match new guide attached". He threatens to cancel orders if next shipment does not match the firm hand of the new guide you have never seen before. You say to yourself, "that is easy", and you add 3% solids of a partially polymerized resin, at no extra cost, and your customer again is very happy. However, six months later the storm really breaks loose and "Mr Customer" doesn't take time to write you but gets on the telephone demanding a settlement at once.

He states that a pair of "pedal pushers" has been returned to him, which show fraying from one week's wear. He further points out that this garment has not yet been laundered, and therefore the condition is a result of poor abrasion resistance.

You look over your formula and see immediately that one change was made during the last six months, and this was the addition of 3% solids of partially polymerized resin, so you are apt to blame this poor wearability on the firm resin. However, this is not necessarily the case. Actually, many partially polymerized resins increase abrasion resistance, but you now have 11% resin in a fabric which, for proper wear results, should have no more than 8% solids. Remember, to begin with you gave your customer 1% less shrinkage than he called for, so, evidently you already had sufficient solids to control the shrinkage. Therefore, to give him the firmness he now wants, it might seem rea-

sonable to replace 3% solids of monomeric resin with 3% solids of the firm resin, producing the firm hand and still keeping shrinkage at a minimum. Actually, you may have to compromise on the crush resistance slightly. Partially polymerized resins in proper concentrations do not affect wearability any more than monomeric resins, but there is definitely a limit to the amount of resin solids any given fabric can take and still show reasonable wear.

This brings up the question of correlating the results of laboratory wear-testing equipment with actual field wear. Various types of abrasion and tear machines are used today, but these accelerated machines do not present the true picture of fabric wearing qualities. This problem is still wide open to research and, I might add, is being considered by numerous chemical manufacturers and finishing plants. Observations *(2)* which deserve further study and research, indicate that abrasion resistance at lower loads is more indicative of wearing qualities. Since abrasion resistance is directly proportional to fiber extensibility, perhaps research will not only find a laboratory test for predicting wearability, but will find methods of increasing fiber extensibility of modified fabrics through lengthening and making more flexible the cross link between the modifier and the cellulose.

Let us now assume we have a mill man here with a minimum of finishing equipment consisting of a pad, tenter frame and Sanforizer, and his boss and principal stockholder doesn't believe in installing necessary equipment for these "new-fangled" processes. You look over Table II and say, "I'll just have to keep on Sanforizing." But, one day *your* customer complains that *his* customer has shrunk goods creeping out right on the cutting table. You call in the finisher and look over the table of finishes again and note that thermoplastic resins require no cure and no afterwash, and you say, "Maybe they are good for the 'creeps'." They are good for "the creeps," and, furthermore, millions of yards of "creep-happy" fabrics have been stabilized against dry stretch with thermoplastic resins in conjunction with Sanforizing.

You should have seen my wife's wedding veil a couple of years after our wedding. She had put it away to keep for a daughter, but in the meantime her sister was getting married and wanted to borrow the veil. This veil was finished with a crisp starch finish and the silver fish had spent an extended honeymoon in my wife's wedding veil, cutting it to shreds. Now, however, the young brides can get wedding veils stabilized with one of the formaldehyde products which "embalms" them against these silver fish.

The ideal stabilized fabric for children's wear might be one with not too much shrinkage and not too much stretch, but just enough shrinkage to take care of a younger one coming along and just enough stretch for a growing child. I do not see any process listed to take care of this problem, so here is a bit of research for a young, ambitious fellow.

Perhaps the research that shrinkage control and stabilization instigated has just begun, and tomorrow will bring fabrics that will not shrink or stretch, will not wrinkle or crinkle, will not wear out or tear out, will not fade or change shade, and will not rot or spot. That, however, would depress the textile business and depress you mill men. Perhaps it is better that research takes years to develop the finished products that are envisioned.

As a parting thought, let us stop to consider that the phenomenal progress in textile finishing with textile chemicals has been made possible through full co-operation between textile-finishing mills and chemical manufacturers. We frankly admit we cannot find all the answers in a beaker, and we need you as a testing ground, as a guide, and as a consumer. We believe you will continue to be benefited by the chemical manufacturers as a source of research, improved chemicals, new chemicals and technical service.

REFERENCES

(1) Wardell, *Cotton*, July, 1940.
(2) Gagliardi, D D; Nuessle, A C, "The Relation Between Fiber Properties and the Apparent Abrasion Resistance of Resin-Modified Fabrics", *Am Dyestuff Reptr* 40, P409, (1951).

9 COLLEGES TO PARTICIPATE IN ALUMNI LUNCHEON AT CONVENTION

AN ALUMNI LUNCHEON, in which nine colleges will participate, will be held on Saturday, November 8, in the Bay State Room of the Hotel Statler during the 1952 Convention.

The Luncheon is designed to provide alumni of the various colleges an opportunity to meet former classmates and fellow alumni. Tables will be clearly marked for each school.

The following groups are actively participating:

Bradford Durfee Technical Institute
Georgia Institute of Technology
Institute of Textile Technology
Lowell Textile Institute
Massachusetts Institute of Technology
New Bedford Textile Institute
North Carolina State College
Philadelphia Textile Institute
Rhode Island School of Design

Among the guests who will extend the greetings of their respective institutions are the following:

Bradford Durfee Technical Institute—Leslie B Coombs, President

A French Textile School (Georgia Institute of Technology) — Herman A Dickert, Director

Institute of Textile Technology—Joseph F Vaughan, President

Lowell Textile Institute — Martin J Lydon, President, and G Nathan Reed, Dean of Faculty

Massachusetts Institute of Technology—James R Killian, Jr, President, and Edward R Schwartz, Professor in charge of the Textile Technology Division

New Bedford Textile Institute—George Walker, President

School of Textiles, North Carolina State College—Malcolm E Campbell, Dean

Philadelphia Textile Institute — Bertrand W Hayward, Director, and Richard S Cox, Dean

Rhode Island School of Design—Max W Sullivan, President, and W D Fales, Head of the Textile School

Special Contribution——

APPLIED SPECTROPHOTOMETRY (I) COLOR MATCHING WITH THE AID OF THE "R" CAM*

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The theoretical background of the function $\frac{(1-R)^2}{2R}$ commonly called the Kubelka-Munk function is discussed. The practical use of this function as plotted by the R cam on the General Electric Recording Spectrophotometer and calculated nomographically are also discussed. The difficulties and advantages of the system as an aid to the color matcher are treated in some detail.

INTRODUCTION

WITH the development, as an accessory to the General Electric Recording Spectrophotometer, of a cam which plots the function log $\frac{(1-R)^2}{2R}$ the usefulness of practical and theoretical results based on this function should receive a much wider usage. In the ensuing discussion we shall be primarily concerned with the application of this function to color problems that occur in the textile industry, for the most part color problems in the dyeing of wool.

A considerable amount of work has been done with the "two-constant" theory in predicting the reflection and transmission characteristics of turbid media. Application has been made to paints, plastics, paper, pigmented films, colored glasses and textiles. To consider in detail the problems inherent in the application of turbid-media theory to each of these areas would be beyond the scope of this discussion.

In order to develop the subject with some logical sequence, it would seem that we should consider first the theoretical aspects and then the application to actual color-matching practice.

THEORETICAL

The development of the theory of the optical characteristics of turbid media has a long history. There have been a great many contributors, and it is not the purpose of this discussion to consider in detail the historical developments. An excellent review of prior work has been given by Duntley *(1)*.

In our work with textile materials, we will consider only a special case of the general theory. Other fields may have different problems requiring a different approach. Along these lines, a large number of modified solutions of the differential equations of Kubelka and Munk, designed to increase their practicality, may be found in an article by Kubelka *(2)*. A lengthy abstract of the original derivation has been given by Steele *(3)*.

Roland E Derby, Jr

In textile applications we are concerned only with the solution of the differential equations for the case of infinite thickness. Infinite thickness is regarded as a sufficient thickness such that any further increase causes no change in the reflectance of the material. The practical methods of obtaining this will be considered later. Such a solution yields the following equations for the reflectance of monochromatic light:

$$R = 1 + \frac{K}{S} - \left[\left(\frac{K}{S}\right)^2 + 2\,\frac{K}{S}\right)\Big]^{\frac{1}{2}} \qquad (1)$$

where S = the scattering coefficient, or fraction of incident energy lost due to scattering in passing through a unit thickness

and K = the absorption coefficient, or the fraction of incident energy lost due to absorption in passing through a unit thickness

It is worth noting at this point that several different approaches to the problem yield essentially the same results *(2)*.

If equation (1) is solved for K/S in terms of R, the following expression results:

$$K/S = \frac{(1-R)^2}{2R} \qquad (2)$$

It is convenient in many cases to represent the ratio K/S by θ. This procedure will be followed in most of the discussion, but when considering θ, one should bear in mind its true significance. Tables of θ as a function of R have been prepared and are very useful *(4, 5)*.

Kubelka and Munk *(6)* and others *(7, 8, 9, 10, 11, 12)* who developed similar equations did not in general relate their function to the concentration of dye or other absorbing material in the material they were considering. The relationship between θ and concentration was postulated by Nolan *(13)* and Foote *(14)* in work on dyed paper. They assumed that the absorption coefficient K was proportional to the concentration and that the dye and fiber scattered and absorbed light independently. In other words:

$$\theta_T = \frac{(1-R)^2}{2R} = \frac{\Sigma K}{\Sigma S}, \text{ where} \qquad (3)$$

$$\frac{\Sigma K}{\Sigma S} = \frac{K_F + K_{D1} + K_{D2} + K_{D3} + \ldots}{S_F + S_{D1} + S_{D2} + S_{D3} + \ldots} \qquad (4)$$

If the scattering coefficient of each dye is assumed to be very small, zero, or a constant for all dyes, then

$$\theta_T = \theta_F + \theta_{D1} + \theta_{D2} + \theta_{D3} + \ldots \qquad (5)$$

$$\text{where } \theta_F = \frac{K_F}{S_F}, \theta_{D1} = \frac{K_{D1}}{S_F} \text{ etc.} \qquad (6)$$

In other words, we are assuming that θ is

* Received by the Editor of the Proceedings in April, 1952.

an additive function.

$$\text{Since } \theta_D = kC_D \quad (7)$$

then, if k is known, C_D can be determined from θ since

$$\theta_D/k = C_D \quad (8)$$

The value of (k) may be determined by measuring θ_D at a known concentration. When the reflectance of a sample of dyed material is measured, the result obtained is not θ_D but $\theta_D+\theta_F$. Hence, in order to determine θ_D we must subtract θ_F from the measured θ. θ_F may be determined by measurements on undyed material similar to that on which the dyeing is to be made.

Notice the similarity between θ_D and the Absorbancy (A) obtainable from transmittance data. By use of measurements at two wave lengths it is possible to determine the amounts of two dyes in a mixture if their constants are known. Similarly, three and four dye mixtures can theoretically be resolved. For the latter, determinants and presolved equations are recommended. The equations are completely analogous to those given by H R Davidson and I H Godlove for solution data *(15)*.

The R cam on the General Electric Spectrophotometer does not plot θ but rather log θ. Further, this is plotted on nonlinear paper whose ordinate reads in reflectance and abscissa in wavelength. The advantages of this particular arrangement will be discussed later. The following equations are useful in manipulating the data obtained. The cam is cut to the function

$$\log \theta, \text{ or } \log \frac{(1-R)^2}{2R} \quad (9)$$

From equations 3 and 5 above,

$$\log \theta_T = \log (\theta_F + \sum_1^N \theta_{DN}) \quad (10)$$

This is the general expression. Let us now consider the case of one dye at two concentrations.

In this case,

$$\log \theta_T = \log (\theta_F+\theta_D) \text{ and} \quad (11)$$

$$\log \theta'_T = \log (\theta_F+\theta'_D) \quad (12)$$

where θ_T and θ'_T represent the values of the function at two different concentrations, by subtraction of (11) from (12)

$$\log \frac{\theta_T}{\theta'_T} = \log \left(\frac{\theta_F+\theta_D}{\theta_F+\theta'_D} \right) \quad (13)$$

From equation (7),

$$\log \frac{\theta_T}{\theta'_T} = \log \left(\frac{\theta_F+kC_D}{\theta_F+kC'_D} \right) \quad (14)$$

By use of this equation the ratio of concentration C_D and C'_D can be determined directly. However, as will be seen shortly, the solution may be obtained more readily by using a modification of this equation and a nomograph. Let us first consider the nomograph. It consists of a celluloid rule marked off in a logarithmic scale similar to a slide rule. It consists of four cycles, which cover the range of the function. The use and construction of such scales is well described by Stearns *(16)*. Scales of this nature are heartily recommended for routine work. They may be prepared to represent almost any function of either reflection or transmission *(4)*.

Since the R cam plots log θ and the celluloid scale is logarithmic, θ may be read directly from the scale. The question may be raised at this point: Why all the complications? Why not plot θ directly and be done with it? The main reason is that the curve shape of a plot of log θ will be sensibly independent of the concentration for most practical concentrations. Among other things this greatly facilitates the identification of dyes at different concentrations. All the considerations that make a log absorbancy plot useful then apply to the log θ plot. Further, by use of the scale, θ can be read very nearly as quickly as it could be read from a plot with θ as the ordinate. The utility of this sort of plotting has been studied and developed considerably for absorbancy data *(16)*.

Returning to Eq 14, we see that by the use of the scale we would read directly

$$\theta_T/\theta'_T = \frac{\theta_F+kC_D}{\theta_F+kC'_D} \quad (15)$$

Since θ_F can be read from the rule, then

$$(\theta_T-\theta_F)/(\theta'_T-\theta_F) = \frac{kC_D}{kC'_D} = \frac{C_D}{C'_D} \quad (16)$$

exactly.

However, in many cases θ_F is generally much smaller than θ_D, and for these cases

$$\frac{\theta_T}{\theta'_T} \sim C_D/C'_D \quad (17)$$

In other words, by reading θ_T/θ'_T from the scale, the ratio of concentrations is determined. Another useful property of this scale is that it is not necessary to set the scale on θ_T but any multiple $\alpha\theta_T$ may be used, as the multiplier cancels in the ratio. This property is extremely useful in practice, as we shall see later.

In some cases it may be desirable to estimate the error caused by the approximation made in Eq 17. The first order error term is shown in Eq 18 and 19.

$$\log \frac{\theta_T}{\theta'_T} = \log \frac{\theta_D}{\theta'_D} + \frac{\theta_F}{\theta_D\theta'_D}(\theta'_D-\theta_D) \quad (18)$$

or

$$\log \frac{\theta_D}{\theta'_D} = \log \frac{\theta_T}{\theta'_T} - \frac{\theta_F}{\theta_D\theta'_D}(\theta'_D-\theta_D) \quad (19)$$

In general, this correction is not important on dyeings of average strength.

It is now possible to apply the equations developed above to practical problems. In so doing, shortcomings and consequent modifications will make themselves apparent.

APPLICATIONS

First, let us consider dye strength. There are many problems involved in the determination of dye strengths and it is not possible to discuss them all here. A very thorough discussion of the problems has been given by Stearns *(17)* and Godlove *(18)*. Many people have advocated measuring solutions, a procedure which has its merits provided cognizance is taken of such problems as pH, exhaustion, complex formation, temperature, aging, etc. In general, it can be said that in many cases it is desirable to determine the strength after dyeing. In "referee" cases, it is the author's opinion that failure to make dyeings (and then at least two of both the standard and the lot) would be extremely foolhardy. There are several reasons for determining relative strengths of dyes. Two of the most important are "substitution" in formulas, and determination of money value. In reality, these two are related, for the concept of money value involves that of substitution. In cases where a considerable shade difference between two colors is involved, the concept of strength and consequently of money value may be nebulous indeed. For example, suppose we have two dyes, a relatively bright blue (A), and a duller blue (B). The money value concept supposes that somehow we could equalize the two for shade. Obviously, this is impossible in a self-shade (that is, the dye alone). However, in composite shades it might be possible to substitute the bright blue for the dull blue by the addition of some other dyes. This could be represented by the equation:

$$B = A + O \quad (20)$$

where O represents orange. It should be noted that A could not be matched with B, as we cannot "subtract" colors. Hence, B's money value, in terms of A, is zero, while A's value in terms of B is given by the cost of A plus the cost of O necessary to make a match. In other words, the

money value of a color really is a function of the shade to be matched. However, it is usually considered that the more brilliant a dye (higher chroma) the greater the economic value, everything else being equal. Such an involved procedure is seldom resorted to in practice. Generally, a standard is set up and it is desired to evaluate a competing dye of the same or similar composition for strength and money value. If the log θ plot discloses curve shape differences of importance (in the region of the absorption maxima, for example) then it is difficult to give an exact evaluation (although, see Godlove, *Ref 18).* This situation does not as a rule please the accountant, who would like the answer to four decimal places if possible! However, let us assume that we have two curves which have the same shape but are merely displaced vertically (see Figure 1). It is then only necessary to place the celluloid "log reference" scale on the paper and read off the ratio of the concentrations, on the basis of Eq 17. It is customary to place the rule at or near the absorption maximum. Since the standard is usually assigned a value of 100%, if the scale is set so that 1.0 is indexed on the standard curve, then the intersection of sample curve and the rule reads % strength of the sample directly (Figure 1). It may be necessary in some cases (yellows) to use Eq 16 if the approximation made in Eq 17 does not yield sufficient accuracy. This can be checked with Eq 19. If the concentration is selected properly, such corrections should not be necessary. This concentration depends on the dyestuff being measured, but generally about 0.5% dyeing (based on weight of material) will be satisfactory. The cam and scale may be used in a similar manner to evaluate color loss in laundering, in light fading (if on tone!), in stripping, and other problems where there is a loss or gain of dyestuffs.

You will recall that it is not necessary to use the absolute value of θ in placing the scale on the paper. The money value of the dye shown in Figure 1 could be obtained neatly by placing the dollars-per-pound cost of the standard on the standard curve and reading the corresponding cost of the competing dye at its scale intersection. Although this method is only an approximation, in the majority of cases the error involved is much less than simultaneous errors in sampling, dyeing, etc.

We shall now consider the problem of color matching, and here we shall rigorously test our theory. Incidentally, it should be pointed out at this point that the "Kubelka-Munk" relation is not the only function relating reflectance to concentration. Others have been derived by Preston *(19),* Selling *(20),* and Pineo *(21).* Good results have been claimed by each for his particular formula. In general, they are too complicated to be of practical use unless mechanical aids, such as cams and nomographs are constructed. An exception is Pineo's function, which closely resembles the Kubelka-Munk function and for which mechanical aids have been designed. The author has not encountered a case in textile work that warranted the use of the other functions over the R-cam function, everything being considered.

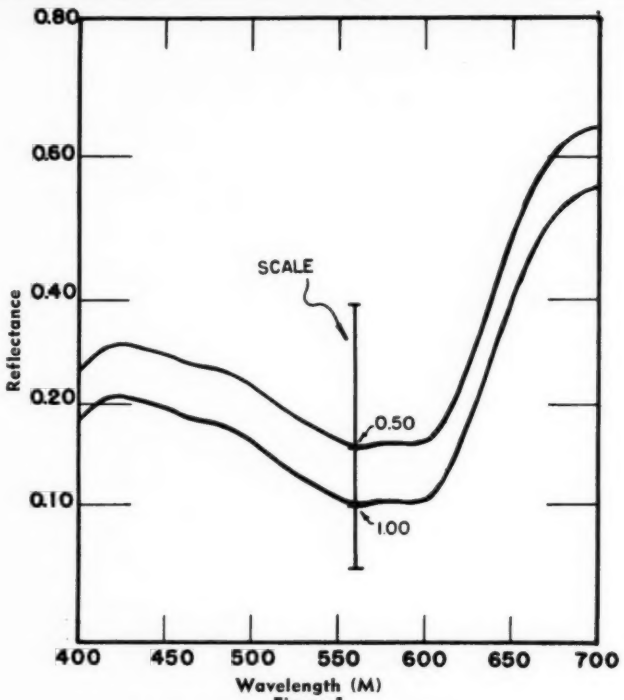

Figure 1
Calculation of Dye Strength With R-Cam

In order to understand the problems of color matching on wool and other textiles, a little background into the procedure commonly used would seem to be worthwhile. The color matching laboratory receives a sample to be matched from either a mill, a buyer, or a dealer. This swatch may be a piece of paper, leather, plastic, or textile material. Usually it is a textile fabric, and, in the wool trade, it is quite frequently wool. If it is not a textile material, then difficulties are encountered in obtaining a satisfactory match because of differences in surface characteristics. Another difficulty which frequently occurs in matching submitted samples is the sample size. It may be only a single yarn or a quarter-inch square of fabric! Let us assume for our problem that the sample to be matched is of sufficient size to be measured by the instrument. The next consideration is the type of material on which the match is to be made. Is it a serge, gabardine, or flannel? Is the stock colored or reworked? Next, what dyes will be used? This is essentially a problem in end use. For example, men's wear is seldom dyed with the same colors as women's wear; automobile cloth does not have the same fastness requirements as casket cloth, etc. Thus, our choice of dyestuffs is governed by such end-use requirements as fastness to light, perspiration, washing, dry cleaning, the price of the garment, and the dyestuffs available to this particular plant. These are the problems of the professional color matcher. The ability necessary to solve them can only be gained by many years of experience in the field. An expert color matcher is an extremely skilled technician, and his services should not be belittled as an aid to the solution of color problems. The quickest solution to these problems may require all the information one can obtain: spectrophotometric curves, tristimulus integration, trick methods of plotting data, advice of color matchers, knowledge of particular mill problems, and any other facts unique to the case. In view of this over-all complexity the solution would almost seem impossible, except by trial and error. However, there is no reason why we should not attempt to decrease our trials and errors. That is the purpose of the procedure to be outlined here. It is an

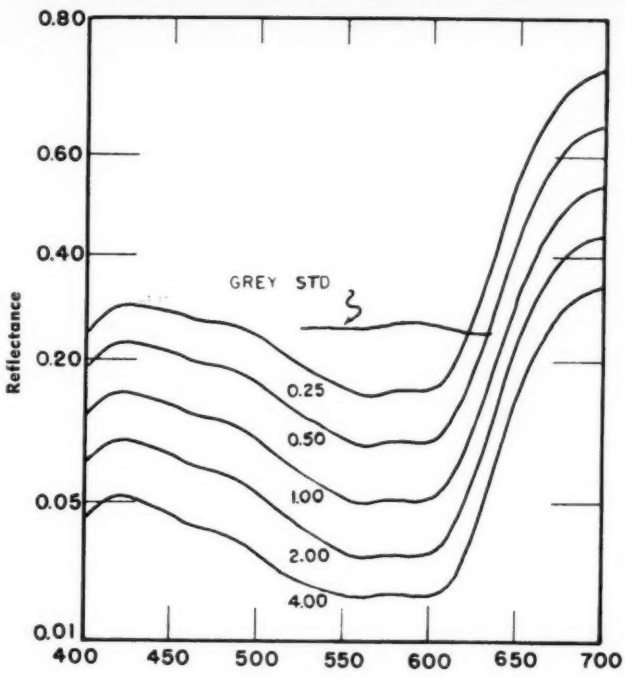

Figure 2
R-Cam Curves for Different Concentrations of Violet Dye

approximate method designed for speed rather than four-place accuracy. However, a careful consideration of the problem will show clearly that, under the present control methods of textile processing, exactness would be physically impossible and philosophically foolish.

Let us assume that we have decided on the class of dyes to be used and also the material. It is now a matter of selecting the dyestuff combination and concentrations to match the shade. The following procedure has been found most useful in the author's laboratory:

All samples of sufficient size are measured on the spectrophotometer as soon as they come to the laboratory to be matched. During rush periods, this may involve as many as 100 shades weekly. A careful study of the R-cam curve is then made, absorption bands and any other unique characteristics being particularly observed. With a little experience, one can tell with reasonable certainty with which class of dyes the sample has been dyed. Further, in many cases difficulties that will occur in matching the shade can be predetermined. There are two cases which arise; either a "curve" match can be obtained, or it cannot. In the latter case a visual or "metameric" match must be obtained. It should be pointed out that if a visual match is required, it must be a match under both daylight and artificial light. Particularly, it must not assume undesirable hues in changing from one illuminant to the other. If, by observation of the absorption bands, "peaks and dips", etc, we decide that the dyestuffs to be used can be made to match the curve closely, then the following procedure is used:

Commence with the dye absorbing at the longest wavelength (a blue, or green). This is based on the practical observation that very few reds, oranges, or yellows have appreciable absorption in the 640-700 mμ region. From a previously prepared plot of log θ at several concentrations (Figure 2), select a curve which has as nearly as possible the same log θ plot. Place the transparent paper (nonlinear) with the sample curve on top of the paper containing the family of curves for the particular dye being used. Slide the paper up or down until the curves coincide. Trace this curve shape onto the paper (see Figure 3). Next, slide the top paper down until it exactly coincides with the paper below. Make a pencil mark on the top paper at the point where the bottom curve falls. Write beside this mark the concentration which appears on the curve below. Next, place the celluloid "log-reference" scale on the paper so that the concentration recorded beside the mark coincides numerically with the scale value. The concentration of blue, or green, to be used is then read off at the intersection of the sample curve with the scale. This calculation makes use of Eq 17. Next, proceed to the left (toward shorter wavelengths) to the absorption band of the next dye—say, perhaps, a red. The differ-

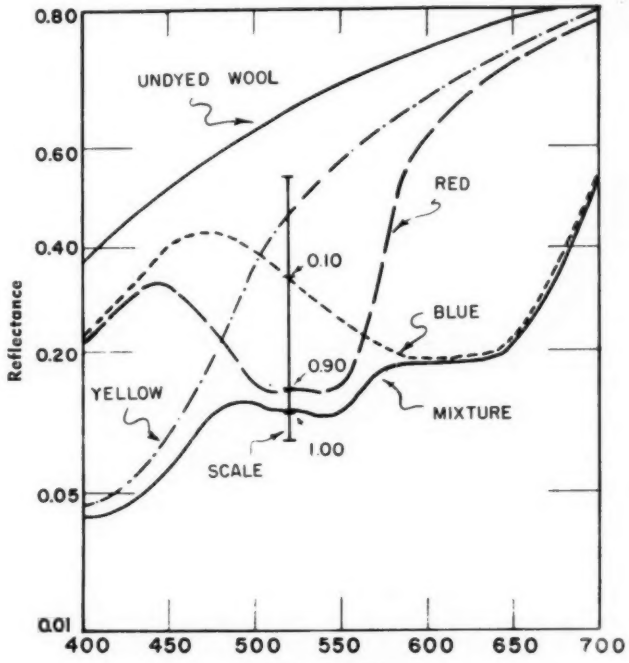

Figure 3
Calculation of Color Mixture

ence here is that the first dye probably absorbs somewhat in this region also. Thus, we must modify the procedure. Place the scale on the plot of the sample at the absorption band of the red dye. For convenience, it is best to place the index 1.0 on the sample curve. When this is done, note where the curve of the first dye crosses the scale. By subtracting this value from 1.0, the value of θ for the red dye is obtained. Make a mark opposite this value on the paper. Repeat the process carried out for the first dye to determine the concentration of the second. This procedure makes use of the fact that θ is an additive function. In other words, from Eq 5

$$\theta_T - (\theta_{D1} + \theta_F) = \theta_{D2} \qquad (21)$$

Actually, in the first case our answer is in error by the amount of θ_F. However, except at very low concentrations, ignoring this is within the accuracy of the method. A correction may be made if desired by cutting a concentration equivalent to θ_F. Remember, however, that the error term in Eq 19 at low concentrations tends to correct the answer in the right direction. This procedure may be extended to whatever other dyes are required to match the curve. Generally, the errors involved become appreciable if more than four or five dyes are used. One point worth mentioning here is the fact that wool has considerable absorption in the region from 400-450 mμ. At low concentrations of yellows, the error term in Eq 19 becomes noticeably large. In applying the method outlined above, in the case of a three-dye mixture, if the other two dyes absorb in the region from 400-420 mμ, then the calculated amount of yellow will be too small by the amount of θ_F. Since θ_F is fairly large in this region, this correction should be applied. It can be easily applied by merely laying the rule on the paper and adding the value of θ_F according to the equation:

$$\theta_x - (\theta_F + \theta_{D1}) - (\theta_F + \theta_{D2}) + \theta_F = \theta_{D3} \qquad (22)$$

In many cases it is useful to consider θ_F as a permanent dye which is "built" into the fiber and thus it is equal to θ for Mgo plus θ of the permanent dye (which is equal to θ_F because θ_{Mgo} is equal to zero). This may sound like undue complication but it is a useful concept in considering stripped goods, or other variations in the substrate.

The above procedure is applicable to cases where suitable dyestuffs can be found to match the curve closely, and where the absorption bands do not overlap badly. There are many cases where this type of solution is adequate. Perhaps 40% of the matches that can be handled are in this class.

Suppose the absorption bands overlap badly, or the available selection of dyestuffs permit only a metameric match. Let us consider first the matter of overlapping bands. There are several ways of handling this problem, among them the method of trial and error must be given due consideration. As we are interested in predicting matches in as few trials as possible, let us see how far we can go by calculation. Solution of the equations of the type described by Davidson *(22)* may be useful at times, but these equations are subject to large errors for dyes with overlapping absorption bands. Another method, which is useful if the two dyes have about the same absorption coefficient, is to calculate the formula for one dye and then to divide the final concentration proportionally between the two. If the absorption coefficients are not the same, then the proportionality will be the inverse of the absorption coefficients. This type of treatment requires a considerable amount of experience, but with experience very good results can be obtained quite rapidly.

Not infrequently, a case will arise where the sample cannot be matched except metamerically, or there are so many factors involved that calculation is of doubtful value. In these instances, the procedures that follow have been found helpful.

In most color matching laboratories it is customary to employ a "shade book". The function of such a book is to aid the color matcher by showing him a large number of combination dyeings, with which to compare the sample that is to be matched. The usual procedure is to compare the swatch (paper, leather, textile etc) with the small swatches in his book until a "good" one is found. A record is kept of the dyes used for each swatch, and also their concentrations. From the color-science viewpoint, there are many factors which should cause trouble in such a procedure: the samples are small, they may have faded, they are probably not of the same texture or surface characteristics as the sample to be matched, etc. However, in practice, over many years, it has been shown to be a definite help to the color matcher.

With this in mind, it was decided to combine this technique with the R-cam data. When a sample to be matched is measured and it is decided that the procedure outlined previously would not be satisfactory, the color matcher is asked to pick one out of "the book" that looks "good". This is done, keeping in mind particularly the change in going from daylight to artificial (Tungsten) light. A Macbeth Color Matching Lamp is very convenient in these cases. The sample to be matched should not reverse itself relative to the swatch in the book in changing illuminants. In other words, if it is red relative to the standard in daylight, it should stay relatively as red under artificial light. A little consideration will show that this requirement means that the samples will match reasonably well throughout the spectrum. Another reason for this procedure is that in the final analysis the samples must be as close a match as possible, under both daylight and artificial light. If not, then people with greater or lesser amounts of filtering pigments in their eyes will disagree on the match. Once the best match is chosen, the R-cam curve for that particular swatch is obtained from the files. If a curve is not available, then one can be drawn from a larger duplicate swatch contained in a separate file. Usually, a curve will be available if this procedure has been in use for some time. A comparison of the curves allows several facts to be determined. Some of them are as follows:

1) Whether the selection was a good one
2) What corrections in the formula will be needed
3) The effect of combination dyeing, such as nonadditivity, changes in exhaustion, and results of overlapping bands

From this knowledge, a corrected formula is given to the color matcher so that his first dyeing will be in the right direction.

It should be noted here, that for small corrections in one or two components very little error is introduced if $\Delta\theta$ is divided by k (in Eq 7), for the dye being changed instead of (k+W). W is a small constant on account of the overlapping of the component bands. As increasing the concentration of one dye causes a change in more than one spectral region, it is necessary to decrease the concentration of the other components which it overlaps. This correction can most rapidly be estimated by multiplying the change in concentration of the first dye (ΔC_1) by the ratio k_1/k_2 (from Eq 7) at the absorption maximum of the second dye. It is convenient to construct a table of these ratios at 10 characteristic wavelengths. Part of such a table (at one wavelength) is shown in Table I. Further, if there are two or three dyes in the formula having absorption in the same spectral region (say red) then a change in concentration (ΔC_1) to make up the deficit must be based on the total θ expressed as red dye.

This procedure cannot be used as yet with samples which are more than slightly metameric. It is hoped that, in

TABLE I

Add

At 480 for .05%, .1%, .5%, 1% and 2%	Fast Light Yellow 2G	Acid Blue ARB	Azo Phloxine GA Ex Conc 100%	Fast Light Orange 2G
Fast Light Yellow 2G	1.0	0.268	5.16	9.36
Acid Blue ARB	3.79	1.0	19.02	35.98
Azo Phloxine GA Ex Conc 100%	0.196	0.054	1.0	1.72
Fast Light Orange 2G	0.112	0.030	0.595	1.0

the future, work with the tristimulus integrator may be developed as an aid in this area. At present, such work can be done more efficiently visually. In using this procedure, it is customary to turn the problem over to the color matcher for final adjustment of the match to visual acceptance. However, he knows that he has a good formula and that he is headed in the right direction. Calculation beyond a certain point is futile at any rate, because of variations in the dyeings themselves. The final match is more or less a matter of chance. Attempts to dye the same formula carefully show variations of at least 1% reflectance in many cases, particularly pastel shades. To attempt to calculate to a greater accuracy than this is usually a waste of time.

Up to this point, we have more or less tacitly assumed that our simplified theory was followed in the cases studied. However, as usual, it is the idealized case and does not represent the true situation exactly, any more than Boyle's Law represents the behavior of a real gas. Consequently, it would seem worth while to discuss some of the inherent and manipulative errors which can cause deviations between the actual and the predicted results. Let us review the assumptions (actual and implied) made in deriving the theory given in the previous section. They are

1) The illumination is monochromatic and diffuse (but see Ref *2)*
2) The material may be divided into an infinite number of thin slices, which do not differ in their optical properties
3) The sample is infinitely thick
4) The absorption coefficient (K) is proportional to the dye concentration
5) The scattering coefficient (S) of the dye is nearly zero, and that of the fiber constant
6) All the diffuse reflectance is measured
7) It is diffuse reflectance (no gloss component, or surface reflection)
8) The derived function is additive
9) The reflectance is determined against MgO

In the next few paragraphs we will discuss a few of the deviations and their effects on the results.

A fair optical model of a wool yarn might be a bundle of cylinders, each of which is composed of more cylinders, and so on, down to the actual protein molecules. Such a model differs considerably from the assumed plane material upon which this derivation is based. In a fabric, however, the resemblance holds more closely. The major portion of reflected light is due to multiple reflections from the individual fibers. Each individual fiber is in turn composed of many regions of different index of refraction. Considering the gross refractive index of wool and normal incidence, a Fresnel surface reflection of about 4.5% would be expected. Other factors tend to make it somewhat larger. This reflection has, of course, not been affected by the dye within the fiber. It enters into the θ_F term and for like materials would cancel.

The illumination in the GE Spectrophotometer is not diffuse and it is also polarized. The latter particularly causes difficulty in the cases of material exhibiting dichroism *(19)*. This effect is most important on fancy weaves, or weaves showing considerable size difference in the warp and filling direction and on dichroic textiles. It can be corrected by the use of retardation plates. Generally, in the case of woolen materials, this effect does not appear pronounced, although special examples can be prepared easily enough.

In order to meet the requirement of infinite thickness, sufficient backing material must be used so that no change in reflectance is noted upon adding more backing. This requirement also specifies that the transmission shall be zero. Hence, a practical test of sufficient thickness is to hold the sample up to a fairly strong light and to notice whether any of the light is transmitted. If only a small sample is available, then it may be backed with a material having similar reflection characteristics.

The assumption that the absorption coefficient (K) is proportional to the dye concentration is only true within limits. Such factors as dye agglomeration, orientation within the fiber, precipitation as pigments, complexes with trace metals, heat sensitivity, etc, may cause deviation on this score. In some fibers, dyes tend to line up along the length of the fiber *(23)*. Since light absorption is greatest when the electric vector is parallel to the long unsaturated chains of the dyestuff, this factor could effect the absorption coefficient on different materials *(24)*. This and other factors, mean that a mere consideration of the reflectance of the base material may not be enough to make the transition from dyeing wool to cotton or other fibers with the same dyes. In practice, it seems as though more dye is needed to dye cotton the same shade as wool than can be accounted for by either its extra whiteness (smaller θ) or difference in dye takeup.

The scattering coefficient of the dye is assumed to be essentially zero, but this is probably not true for all dyes, especially at increased concentrations. It is not inconceivable that the intrusion into the fiber of a sufficient number of relatively large, bulky dye molecules should alter its optical properties similarly to the effects of added moisture or inorganic chemicals. Changes in scattering, by changes in particle number and size due to Rayleigh scattering, fiber fineness, chemical surface damage, etc, appear as variations in the scattering coefficient. It is not the place here to discuss these effects quantitatively. Very lucid descriptions of Rayleigh and diffraction scattering may be found in articles by Clewell *(25)* and Bender *(26)*. It should be stated here that the effect of molecular changes on the scattering power of such complex materials as wool and dyestuffs is probably impossible to predict at present. However, such effects must be kept in mind as possible explanations to various anomalies, which occur from time to time.

Of the remaining assumptions, numbers (6), (7), and (9) are probably the least seldomly adhered to in practice. However, with the optical system of the General Electric Spectrophotometer, little difficulty due to these variables seems to exist in most textile work, at least not enough to warrant going to the trouble to correct them. A good white should be used, preferably MgO, but in view of the difficulty of maintaining MgO (or $MgCO_3$) it may be desirable to use a suitably calibrated Vitrolite tile for routine work. It would probably be appropriate here to mention that pile fabrics do not lend themselves very satisfactorily to color matching by the methods outlined above, as they always appear heavier than their actual dye concentration would indicate. Heavily napped materials, such as plushes, also exhibit this behavior. Usually, for any given case, correction factors can be established by experimentation.

Assumption number (8) is a source of considerable difficulty in some cases. It has been shown both in solutions and on

the fiber that an appreciable number of dyestuffs unite to form agglomerates (dimers, trimers, etc) within themselves *(23)*. It is not unreasonable that they also form such complexes with other dyestuffs. This has proved to be the case in some instances. At any rate, there are some situations where the "additive" function is not additive, whatever the reason may be (Davidson, *27)*. However, it is possible to make allowance for these cases once they have been discovered. For a detailed discussion see Stearns *(16)*. Along this line, many workers have felt that there are so many variables involved in predicting concentration from reflectance, or vice versa, that you would do as well to determine the relationships for each dye experimentally. Such strictly empirical approaches suffer in that they give little help in studying new problems or explaining baffling results.

Another factor to be considered is dyebath exhaustion. The dyer or color matcher wishes to know how much dye he needs in the bath to obtain a certain shade on the material. The ability to predict this presupposes a knowledge of the dyebath equilibrium exhaustion. Practically, this means how much dye will be left in the bath after the dyeing has been completed (in the economic sense). The equilibrium exhaustion of a dyebath is a function of many things: pH, temperature, concentration, salt content, surface-active assistants, particular material being dyed, and the dyeing method. Most of these factors are held reasonably constant in cases where they are important. If they are not held constant, serious errors in the dyeing results may occur. The most important variable affecting exhaustion in matching shades in the laboratory is concentration. For example, a dye at 0.05% concentration may exhaust nearly 100%, whereas at 2% the same dye may exhaust only 50-60%. The curve of exhaustion vs concentration differs for each dyestuff and must be determined experimentally. This effect causes an apparent variation in the constant of Eq 7, if it is given no consideration. This may be handled in one of two ways:

(1) Either residual dye in the dyebath may be measured and the actual dye on the fiber determined, or

(2) It may be ignored and a "variable" constant used in Eq 7.

Over short concentration ranges, the effect is generally negligible. Hence, by use of the family of curves (Fig 2) with the *dyebath* concentrations written beside them, consideration is automatically taken of this variable. In converting laboratory formulas to mill dyeings, it is customary to cut 5% to 10% from each dye, as it is easier to make an addition than to remove the dye if an error has been made.

In some cases it may be desirable to know the actual (k) for the dye. The first method enumerated above should then be used. It is found in some cases that even then the "constant" is not always constant because of discrepancies similar to those found in using Beer's Law in transmission studies. This variation is automatically corrected for by using the "family-of-curves" method.

If the material being dyed has a considerably different θ_V than the material from which the curves were prepared, the amount of dye may have to be increased or decreased by the difference $(\theta_V - \theta'_V)$, depending on whether the sign is positive or negative.

TABLE II

	Acid Blue ARB	*Azo Phloxine GA Ex Conc CI 31*	*Fast Light Yellow 2G CI 639*	*Fast Light Orange 2G CI 27*	*Naphthalene Green 2G CI 735*
	%	%	%	%	%
Actual	.5		.2		
Calculated	.55		.19		
Actual	.5	.1	.2		
Calculated	.55	.09	.15		
Actual	.5			.2	
Calculated	.54			.19	
Actual	.5	.1		.2	
Calculated	.54	.1		.16	
Actual	.5		.2		
Calculated	.54		.21		
Actual	.5		.2	.1	
Calculated	.54		.17	.1	
Actual		.1	.5	.2	
Calculated		.12	.40	.21	
Actual			.5	.2	
Calculated			.4	.21	
Actual	.1		.5	.2	
Calculated	.104		.48	.2	
Actual			.5	.2	
Calculated			.45	.2	
Actual	.1	.2	.5		
Calculated	.107	.18	.48		
Actual		.2	.5		
Calculated		.194	.5		
Actual			.5		.4
Calculated			.46		.42

These dyeings and the calculated matches were prepared for the author by Therese Commerford of the color matching laboratory of The Derby Company, Inc.

CONCLUSION

It has not been possible in this brief paper to cover all the problems in the coloring of textiles whose solutions are amenable to use of the R cam and some ingenuity. In order that you may have some idea of the results obtainable by this method, Table II contains some experimental results on samples of known concentration. These results would have constituted the first trial. Davidson *(27)* has reported that calculations based on this function yield results with acid dyes accurate to ±0.5 hue step, ±0.1 value step, and ±0.4 chroma step. These are not isolated cases, but rather, typical of hundreds of matches that have been made in a routine way. It should be admitted, however, that the procedure works best for acid colors and the examples are dyed with acid dyes. After all, even three or four trials in many cases is an improvement, when the author has seen color matchers not too infrequently make twenty! The formulations arrived at in this table can be obtained in fifteen minutes or less once the curve has been drawn.

A word of pessimism is due, however, since considerable practice is necessary to utilize the method to the best advantage. There are more than a few cases where the procedure does not yield satisfactory results because of metamerism, fiber or yarn mixes (unions), peculiar behavior of dyestuffs in mixtures, errors in preparing the original dyeings, and samples too small to be measured.

The method appears to be satisfactory in limited experiments with nylon, Orlon acrylic fiber and Dacron polyester fiber. However, the dyeing of these fibers at present is quite difficult and noted for its lack of consistency, so that predicting results is quite uncertain. An R-cam plot is still the most useful, though, even in these cases as it permits easy dye identification. Davidson *(27)* has shown it to be satisfactory for acetate dyes and for vat dyes on cotton. In the cases of very dark shades (less than 5% reflectance), the function appears to fail. A plot of log θ vs log C has been found to give a straight line in many of these cases *(5)*.

In conclusion to an already overlong discussion, it should be stressed that the method outlined above is merely one which has been very successful in the author's laboratory. It may not be useful to you. Your particular problem may require modification of both the method and the equations. This method has been

used in countless ways. More curves are drawn with the R cam than with any other. It is the author's opinion that "matches" should be made as close to the curve shape of the standard as possible even at the expense in some cases of using four dyes instead of three. It is a considerable aid to understanding the color phenomena involved in color-mixing. A dyer or color matcher, well versed in his field and with a thorough knowledge of the principles of spectrophotometry and the use of the R cam could increase his efficiency considerably. Unfortunately, such a combination has in the past been exceedingly rare.

The author would like to take this opportunity of thanking Dr E I Stearns, H R Davidson and F J O'Neil for their aid and encouragement in preparing this paper.

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Colour Index Paper Consignment Arrives in England

WILLIAM H CADY, Chairman of the *Colour Index* Committee, was recently notified in a letter from H Blackshaw, Society of Dyers & Colourists, of the arrival at Manchester, England of paper purchased by the AATCC for use in publication of the new *Colour Index*. Mr Bradshaw's letter, dated June 12, reads in part:

"We have just received copies of the photograph taken by our agents at this end, of the consignment of paper after being unloaded at the Manchester Docks, and on this matter I would refer you to our Minutes, PM/81/1254. You might be interested to note the following facts. This consignment was conveyed by S S "American Chief", which sailed from Boston on May 11, 1952, and arrived at Manchester on May 23. The consignment consists of 252 cases with a net weight of paper—62 tons (long tons). There are 1512 reams of paper, which at 500 sheets per ream works out to 756,000 sheets each 45" by 35". It may interest your statistically-minded friends to know that if these 756,000 sheets were placed end to end (45" direction) they would stretch for 537 miles!"

The extract from PM/81/1254 reads as follows:

"The paper purchased by AATCC has arrived at the Manchester Docks per S S American Chief on May 23. The various customs formalities, etc, have been completed and the consignment would be split into two parts, one part going to Chorley and Pickersgill and the other to Lund Humphries. The Panel were very gratified to learn of the completion of this purchase and noted with interest that our agents, Van Oppen & Co, had taken photographs of the consignment on the dockside at Manchester. Copies of these photographs would be available and it was agreed that a copy should be sent to Mr Rhodes of the Lancashire Press Agency. A copy would also be sent to AATCC."

The consignment of paper purchased by the AATCC for the Colour Index stands unloaded at Manchester Docks

ONE HUNDRED AND EIGHTY-SECOND COUNCIL MEETING

THE Council held its 182nd meeting in the Hotel Statler, New York, N Y, on Friday morning, June 13, 1952. Present were President C Norris Ra.old, *presiding*; Samuel L Hayes and Raymond W Jacoby, *Vice Presidents*; William R Moorhouse, *Treasurer*; Leonard S Little, *Chairman of the Research Committee*; William H Cady, Carl Z Draves and P J Wood, *Past Presidents*; Edward B Bell, John M Gould and George O Linberg representing Northern New England; Aiden D Nute and James A Stevenson representing Rhode Island; J Edward Lynn representing Western New England; Charles W Dorn, William A Holst, Patrick J Kennedy and Paul J Luck representing New York; James Dixon, Thomas H Hart, Joseph W MacNeil, Ernest E Rettberg, Jr, Richard B Stehle and Jackson A Woodruff representing Philadelphia; Henry A Rutherford and R Hobart Souther representing Piedmont; Kenneth H Barnard of the Conventions Committee; George L Baxter of the Corporate Membership Committee; George H Schuler and Glenn D Jackson, Jr of the Publicity Committee; Harold W Stiegler, *Research Director*; Percival Theel of the Publications Committee; and Harold C Chapin, *Secretary*.

The Secretary's report of the 181st Council meeting and financial report of May 23, and the Treasurer's report of May 27, were accepted. A budget for the year beginning August 1st was adopted. The budget for the current year was amended to cover legal expenses on the *Colour Index* contract. The Appropriations Committee was asked to investigate employment of regular legal counsel and to report at the next meeting.

Professor Theel reported that manuscript for the Vat Dyeing monograph was complete and ready for bids on publication. The *1952 Year Book* would be out in September. Part Two of next year's book would be divided into two sections, research and other material, respectively. Under Textile Chemical Specialties entries per manufacturer would hereafter be limited to avoid duplication of a product in but minor modifications. From this year's book, one thousand copies of Part Three (Test Methods), would be bound separately in paper covers and sold for about one dollar per copy. Mr Cady stated that printing of the *Colour Index* would start this year but would not be complete before 1955. The paper had been delivered in England. Thanks were voted to Mr Sampson's committee for handling purchase and shipment. Proposals from England to take advance subscriptions for the *Colour Index* at reduced prices were being considered and probably would be adopted.

Mr Baxter stated that his committee was aiming at the enrollment as Corporate members of some eighteen hundred companies now represented by personal, but not Corporate, memberships in the Association. Mr Souther described the activities of his Piedmont Section in research and the enrollment of Corporate members.

According to Mr Little, the staff in Lowell was working on dry cleaning, wash and light fastness, and simplified control tests. The American Viscose scholarship was being renewed and a graduate student being sought for the work. At our exhibit in the convention of the Canadian Association of Textile Colourists and Chemists particular interest had been shown in tests for fastness to light, washing and perspiration. An exhibit was also slated for the convention of the Home Economics Association in Atlantic City during the week of June 23. I S O meetings were in progress in New York at the time of the Council meeting with committee meetings on shrinkage scheduled to start June 16. Gas fading in gas-heated tumble dryers was under investigation. Mr Seibert was making comparative tests on a new and more elaborate model of the Fade-Ometer. At the Research Committee meeting that afternoon Mr Dorn showed a J C Penney Co film on textile testing, which reportedly would be available generally in November.

For the Conventions Committee Mr Barnard recommended Regional conventions in the future; in line with this, a convention in the Chalfonte-Haddon Hall, Atlantic City, September 21 to 25, 1955. This was approved. For the Intersectional Contest of this year Mr Gould reported that papers had been promised by six Sections. Every Section was invited to appoint a judge. At request of Mr McCann, the tentative rules for the Student Contest were approved.

Mr Hayes stated that the President's Advisory Committee, working on suggestions of an earlier committee relative to a business manager, had decided to draw up a wholly new report, which it hoped to have ready for the September Council meeting. Meanwhile Section chairmen would be urged to consult their Sections and send in suggestions.

For Council meetings of 1953 the dates January 16, April 17 and June 5 were chosen, in hope that at this early date there would be no conflicts with scheduled Section meetings, but with request that any such conflict be reported to the Secretary immediately.

On applications presented by Mr Jacoby, Cellusuede Products, Inc, Smith Drum & Co, Western Felt Works and Western Piece Dyers & Finishers, Inc, were elected to Corporate membership, and each of the following was elected to the class of membership specified, as of thirty days from publication of application, provided no objection be received meanwhile by the Secretary.

SENIOR

Addison, W P
Alkus, W S
Antich, R
Austin, J
Barnet, H B Jr
Batson, C K
Berg, E S
Bhaty, F M
Birkett, E F Jr
Caryl, C R
Cruickshank, W E
Chute, C R
Clasgens, V P
Chittenden, P A
Echerd, C P
Fahey, T J
Feild, T A Jr
Fenrich, E G
Frey, H H
Green, L Q
Hadfield, J C
Hammell, C L
Heggie, D
Heyman, K
Hill, E B
Hutchinson, W R
Jones, J H
Kibbel, W H Jr
King, W H
Kramer, M G
Laramee, I F
Loebel, W
MacConville, J E
McChesney, L K
McNamee, J N
Nakajima, T
Nyman, E G
Ostern, W C
Puliafico, S J
Richardson, H
Rishton, J H
Ruhf, C
Selg, H L
Shelton, J H
Shenton, H
Simpson, W R
Spoon, C M
Stinson, T A
Thiernagand, J A
Turck, J W
Wagner, R J
Wesson, S
Wills, C

JUNIOR

Carlson, R V Jr
Cozzens, C C
Deaton, D B
Fitzgibbons, G J
Gaddes, W A
Getty, S E
Griffin, T F
Noon, H J
Porter, J B
Provenza, L J
Restrepo, R P
Sharpe, R C
Sheehan, L C Jr
Smith, B F Jr
Smith, J C
Tatlis, J A

ASSOCIATE

Christie, J S	Malizia, R
Cole, T F	McArthur, A L III
Comer, W C Jr	McGuinness, J J
Cramer, P C	Mellin, H S
Culver, T C	Morin, R C
Dailey, T H	Streitzig, W H
Davis, M E	Sullivan, J J
Lodovico, L	Wilson, G E Jr

STUDENT

Celikiz, G	Martinez, H C
Da Silva, M A	

Each of the following was transferred from other classifications to Senior membership:

Bizioli, O H	Wright, V B Jr

Respectfully submitted

H C CHAPIN
Secretary

SECRETARY'S FINANCIAL REPORT — MAY 23, 1952

	Applications	*Dues, regular & reinstate*	*Dues, Corporate & Sustaining*	*Miscellaneous*	*Totals*
Received and transmitted to Treasurer					
August 1, 1951 to March 21, 1952...	$3,899.00	$42,155.25	$43,527.50	$11,939.48	$101,521.23
March 21 to May 23, 1952.....	725.50	538.00	955.00	2,377.13*	4,595.63
Total in fiscal year to May 23.....	4,624.50	42,693.25	44,482.50	14,316.61	106,116.86
Leaving deposited by Treasurer with Secretary					9,331.80
					*
Miscellaneous items					
Dividends and interest					$ 581.90
Reporters and reprints					52.95
Year books					306.00
Crockmeters					403.61
Crock cloth					303.72
Moth cloth					20.00
Water test apparatus					188.40
Dyed standards					192.00
Knitted tubing					58.80
Gas fading unit					1.00
Buttons					14.00
Color transfer charts					122.50
Analytical Methods					114.25
Grease wool					18.00
					$2,377.13

H C CHAPIN
Secretary

RAPID CONTROL TEST TO INDICATE COLORFASTNESS TO PERSPIRATION*

Tentative Test Method

71-52

Purpose and Scope

This is a simplified rapid method for screening perspiration fastness of colored fabrics. This test is not intended to supersede the Standard Perspiration Test Method No 15-52 which is recommended for use in referee cases.

This method of test is applicable to dyed or printed fabrics.

Principle

Test specimens are spotted with the specified perspiration solution, covered with a blotter and heated under a flat iron for 5 minutes. The blotter is then examined for transfer of color from the test specimen.

Apparatus and Materials

Stainless steel plate (or other equally resistant surface).

Flat iron (or other heat source, thermostatically controlled).

Pipette, 10 ml.

White AATCC Textile Blotting Paper, 3″ x 3″ (*1*).

Test solutions:

Acid Test Solution

Per Liter

10 g Sodium chloride
1 g Lactic acid, USP 85%
1 g Disodium orthophosphate, anhyd

Alkaline Test Solution

Per Liter

10 g Sodium chloride
4 g Ammonium carbonate, USP
1 g Disodium orthophosphate, anhyd

Test Specimens

Two 3″ x 3″ pieces of fabric (one for each of the test solutions).

Procedure

Place a test specimen upon the stainless steel plate and pipet 0.5 ml of the acid test solution onto the specimen. Cover the spotted specimen with a blotter, and place on it a flat iron heated to 250°F (121°C) (*2*). After 5 minutes separate the "sandwich" and examine the blotter for the degree of color loss from the specimen.

Repeat the above procedure with alkaline test solution.

Evaluation

Color transfer from the fabric on the blotter indicates that the color is susceptible to the specified perspiration solution. For finer control the standard method (No 15-52) should be used.

Notes

(*1*). White AATCC Textile Blotting Paper is obtainable from Standard Paper Manufacturing Company, Richmond, Virginia, attention of J S Walden, Sales Department. This blotting paper is the same as that used in Water Resistance Test No 35-52.

(*2*). The iron temperature can be measured with a surface pyrometer or a 250°F Tempilstik (Cenco No 13756).

* This test is the second of a series planned by the AATCC Research Committee on Simplified Wet Control Tests to provide rapid screening methods. These tests are intended as auxiliary tests to indicate results which may be expected from the longer and more detailed standard tests.

RAPID CONTROL TEST
COMBINED COLORFASTNESS AND SHRINKAGE
EQUIVALENT TO FIVE COMMERCIAL LAUNDERINGS*

Tentative Test Method
72-52

Purpose and Scope

Color loss, abrasive action and shrinkage of five average commercial or home launderings are approximated in one 45-minute test. Due to the size of the specimen used the precision of this test does not equal that of the standard AATCC test method (No 14-52) for "Dimensional Changes in Textile Fabrics" which is recommended for use in referee cases. This accelerated laundering test is applicable to cotton and linen fabrics.

Principle

Test specimens accurately marked for shrinkage measurements are laundered under conditions designed to increase the abrasion factor by means of the larger metal containers in the Launder-Ometer, low liquor ratio and increased number of steel balls. These specimens are finally measured for shrinkage and evaluated for color loss.

Apparatus and Materials

Launder-Ometer (*1*).

Inconel cylindrical containers, 3½″ x 8″ (*1*).

Metal adapters (to hold containers on Launder-Ometer shaft) (*1*).

Stainless steel balls, ¼″ dia (*1*).

Extractor.

Flat iron or flat-bed press.

Ruler with 1/50th″ scale.

Soap (Federal Spec PS 566 or ASTM D496).

Sodium metasilicate, technical (Na_2SiO_3-$5H_2O$).

Acetic acid, 28%.

Unsized, bleached cotton cloth, 80 x 80.

Test Specimens

One 5″ x 5″ specimen is used in each container. A 2″ square of 80 x 80 bleached muslin may be attached to each specimen to determine staining.

Procedure

Mark off accurately three 4″-distances in both warp and filling directions on the specimens. Such marks should be ½″ from all edges.

Adjust the Launder-Ometer to maintain a bath temperature of 160°F (71°C).

Prepare the required volume of wash liquor, 50 ml for each test, made up to contain 0.2% soap and 0.2% sodium meta silicate. Preheat the solution to 160°F (71°C) and measure 50-ml portions for each test into separate beakers. Enter a well crumpled test specimen into each beaker and thoroughly saturate with warm solution.

Place 100 steel balls into each container and clamp the covers. Place the containers horizontally in the adapters on the rotor of the Launder-Ometer with the covers facing the operator and arranged so that an equal number of containers is on each side of the shaft. Start the rotor and run for not less than two minutes to permit the containers to preheat to 160°F (71°C).

Stop the rotor and with a row of containers in an upright position unclamp the cover of one container, enter a test specimen and the solution and replace the cover but do not fasten it. Repeat this operation until all containers in the row have been loaded. Then clamp the covers in the same order in which the containers were loaded. Cover clamping is delayed to allow equalization of pressure. Load the second row of containers in the same order.

Start the Launder-Ometer and run for 45 minutes. Stop the machine, remove the containers and empty the contents into a colander. Rinse each test specimen twice, in beakers, in fresh 100-ml baths of water at 105°F (41°C), for one-minute periods with occasional stirring or hand squeezing. Sour in 100-ml of a 0.014% solution of acetic acid (0.5 ml of 28% acetic acid per 1000 ml of water) for one minute at 80°F (27°C). Rinse again for one minute in 100 ml of water at 80°F (27°C). Hydroextract to 55% moisture content.

Pressing

Smooth each specimen to remove wrinkles before pressing. Press the specimens with a hand iron or with a flat-bed press, taking care in handling to avoid distorting the cloth. When pressing with a hand iron do not slide it on the specimen but press down in a manner simulating the action of a flat-bed press. Allow the specimens to cool before measuring.

Evaluation

Lay pressed specimens without tension on a flat surface, so that the cloth is smooth and free from wrinkles or creases. Remeasure the marked-off distances and report the average change to the nearest per cent.

Examine the same specimens for color loss and the attached white cloths for staining.

Notes

(*1*). Atlas Electric Devices Company, 361 West Superior Street, Chicago 10, Illinois.

* This test is the third of a series planned by the AATCC Research Committee on Simplified Wet Control Tests to provide rapid screening methods and multi-purpose or "combined" tests. For more precise results the longer, detailed standard methods should be used.

NEWS

• New Carbide Plant to Produce Polyethylene Resins

Design and engineering work are underway, and Certificates of Necessity have been issued by the Defense Production Administration, for a new plant in Los Angeles, California for Carbide and Carbon Chemicals Company, a Division of Union Carbide and Carbon Corporation, at which polyethylene resins and ethylene glycol will be produced, it is learned. The project, according to the Certificates of Necessity, will involve an eventual investment of upwards of $36 million. Plans call for the production of from 50 to 60 million pounds of polyethylene and from 5 to 10 million gallons of ethylene glycol a year.

The new plant, the exact location of which has not yet been announced, will reportedly be the first on the Pacific Coast to manufacture polyethylene and ethylene glycol, and it is expected to supply the needs for these materials for the West Coast and the Mountain states. According to Carbide, it will not contribute to the air pollution problems of the Los Angeles area since no acids will be used whatever in the chemical operations involved, and no fumes will be given off. Natural gas will be used as a fuel for the boilers and, as a consequence, no more smoke will be produced than is generated by gas refrigerators or the gas stoves used in homes, it is pointed out.

• Atlas Opens New Office in Southwest

In order to provide additional service for users of its industrial chemical products in the Southwest, Atlas Powder Company, Wilmington, Del, has opened a new office in Houston, Texas. The move, according to George J King, is the latest in a series of steps planned to expand the services of the Company's Industrial Chemicals Department, which manufactures and markets sorbitol, mannitol, surface-active-agents, polyester resins, plasticizers and other products.

Allen V Riley, Jr has been assigned as technical sales representative to the office, which will service Texas, Louisiana, Colorado, New Mexico and parts of Mississippi. Mr Riley has been with Atlas since 1938, previously in the Chicago sales office.

ADR NOW AVAILABLE ON MICROFILM

Arrangements have been completed with University Microfilms, 313 North First Street, Ann Arbor, Michigan, for supplying subscribers of the Reporter with a microfilm edition. This arrangement is effective with the 1952 volume. The film copy will be delivered at the end of the volume year for those who subscribe to the service and it will include all issues published during that period. It is estimated that the film edition requires only 5% of the space required for the paper edition, which is bound. Complete information is available from University Microfilms.

• Interchemical, U S Testing Enter Certification Agreement

A unique certification agreement between Interchemical Corporation, Textile Colors Division, Hawthorne, New Jersey, and the United States Testing Company of Hoboken, New Jersey has recently been entered into, covering the certification of the colorfastness to light, washing, and crocking of Aridye® Pigment Colors when applied to synthetic fabrics by commercial textile printers. This agreement marks the first time that a pigment print has been certified by U S Testing, indicating the technical progress that has been made in the pigment printing field by Interchemical.

The agreement, although certifying a product manufactured by Interchemical Corporation, reportedly applies to the finished product as it leaves the printers.

Under the terms of the Certification Agreement, the customers of Interchemical, who contract for this certification, will use Aridye Colors in the prescribed manner and upon completion of the printing operation, representative samples of each lot will be sent to the United States Testing Company for testing as a further quality control. U S Testing will also have the right to take random samples for test from the printing plant and to obtain samples of material printed with Aridye Colors in the open market. Colorfastness to light, washing, crocking, and other tests will be performed on all of the samples, and the printers will be permitted to use the Seal of the United States Testing Company on all materials that meet the required standards. Standard test methods as outlined by the A A T C C are reportedly used in this program.

Since the actual application and processing method play an important part in determining the appearance and quality of printed fabrics, the certification plan is designed to assure the proper application of the Aridye Colors and insure the colorfastness of each lot printed.

• Outstanding Geigy Contribution to Medicine

Geigy Company, Inc, producers of dyestuffs since 1859, makers of Mitin durable mothproofer, and originators of DDT Insecticides, recently made another outstanding contribution, this time to the field of medicine.

First reports of the performance of Butazolidin (phenylbutazone) for the relief of arthritis and allied disorders were made available at the Convention of the American Rheumatism Association in Chicago during June.

Clinical reports reportedly indicate a high degree of effectiveness with a minimum of side reaction.

• Vulcan Sales Appointed Agents for ARC, APC

American Resinous Chemicals and American Polymer Corporation have appointed Vulcan Sales Company, 7414 Jarboe Street, Kansas City, Missouri, as agents in the states for Iowa, Nebraska, Kansas, Oklahoma, Northern Texas and Western Missouri.

E L Klein, Proprietor of Vulcan Sales, is a native of Kansas City and has been in chemical sales for the past seven years. He will handle American Resinous' and American Polymer's latest developments in the fields of latex paints, soil conditioners, coatings, saturants, binders and adhesive bases.

• Lecture Series on Dyestuffs

The Summit Lecture Series Committee of the North Jersey Section, American Chemical Society, will sponsor a new series, "The Chemistry and Application of Dyestuffs" to be held at the auditorium of the Central Laboratories of the Celanese Corporation of America, Morris Court, Summit, New Jersey, on successive Tuesday evenings beginning September 30, 1952 at 7:00 PM. The lecturers have been chosen from among the leaders in the respective fields. The complete program:

September 30—"Colorimetry," Dr E I Stearns, Calco Chemical Div, American Cyanamid Co

October 7—"Physical Chemical Aspects of the Adsorption of Dyes by Fibers," Dr H J White, Jr, Textile Research Institute

October 14 — "Chemical Constitution and Color," Dr L G S Brooker, Eastman Kodak Co

October 21 — "The Chemistry of Azo-Dyes," Dr N M Mackenzie, Calco Chemical Div, American Cyanamid Co

October 28—"The Chemistry of Phthalocyanine Dyes," Dr R L Brouillard, General Aniline Works

November 4—"The Chemistry and Application of Vat-Dyes," Dr M R Stevinson, General Aniline Works

November 11—"The Chemistry and Application of Pigments In Textile Decorating," Dr Z W Wicks, Interchemical Corporation

November 18—"The Dyeing of Newer Fibers," Dr A L Peiker, Calco Chemical Div, American Cyanamid Co

November 25—"The Chemistry and Application of Fabric Finishes," A C Nuessle, Rohm and Haas Company

December 2—"Consumer Demands and Fastness Requirements," C W Dorn, J C Penney Company

Additional information may be obtained from Anthony B Conciatori, Chairman, Summit Lecture Series Committee, Celanese Corp of America, Summit, N J.

• Central Scientific Finds New Use For Measuring Device

Central Scientific Company, Chicago, Ill, recently announced the discovery of an application in the textile industry for one of its established products, a measuring apparatus for heat conductivity originally designed for other industrial and laboratory uses.

The insulating quality of blankets, overcoats and other fabrics also can be tested accurately and quickly by the instrument, which until recently was thought to be capable of measuring the thermal conductivity of only such materials as blotting paper, wallboard, glass and all types of insulating materials, according to a statement by John T Gossett, president. Textile manufacturers, he explained, are thus enabled to compare the warmth-retention qualities of various fabrics and to maintain specific standards before distribution to the garment industries.

According to Mr Gossett, a layer of the material being tested is brought in contact with the measuring device which is filled with boiling water and kept at a constant temperature by an immersion heater. The material is then placed on a receiving block of metal of known heat capacity. The temperature changes in the receiver, as affected by the heat being conducted through the material, are measured by means of a thermocouple and the rate at which the receiver increases its temperature determines the insulating value of the fabric.

Well-insulated materials will cause the receiver block to warm up more slowly than those which are poorly insulated, Mr Gossett explained. He also pointed out that the device is useful for measuring the lack of thermal conductivity, providing textile manufacturers with a positive means of determining the most comfortable fabrics for summer as well as winter.

The instrument, he said, is simple to operate and nondestructive to the material being tested.

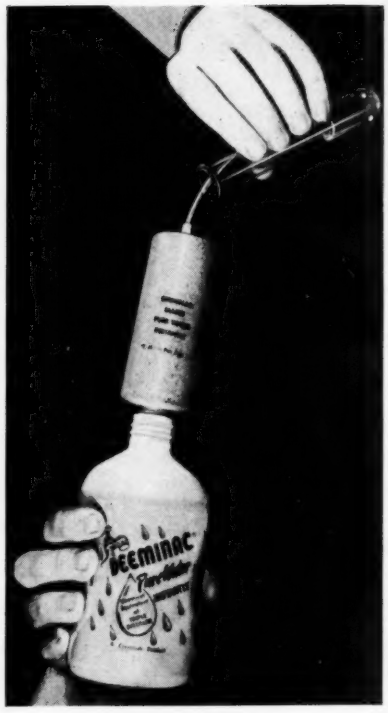
• Malibu Fabrics Inaugurates New Technical Information Service

The formation of a free Technical Information Service Department for corset, brassiere and swimwear manufacturers and stores has been announced by Sidney J Gluck, president of Malibu Fabrics, Inc, manufacturers of elastic fabrics.

"Retailers and manufacturers—anyone in the trade who uses or sells elastic fabrics —may call upon this Service Department," states Mr Gluck, "for information on the full possibilities and uses of woven elastic fabrics."

Malibu is said to have had many queries concerning changes of color in these fabrics, the most suitable percentage of stretch, advisable breaking strengths, color fastness requirements and norms, causes of loss of stretch, washability, care, upkeep and many others.

"If there are any questions on any of these topics," Mr Gluck continued, "or about the weaving and manufacturing techniques employed in the creation of these elastic fabrics, their cutting, finishing, care and cleaning—the Malibu Technical Information Service will try to provide the answers, without charge of course." All questions should be addressed to Malibu Fabrics, Tech Information Service, 350 5th Avenue, New York, N Y.



"Deeminac"

• "Deeminac" Water Purifier

A handy, economical devise for making raw water chemically pure is currently being manufactured under the trade name "Deeminac" by E Machlett & Son, 220 East 23rd St, New York 10, N Y.

The new device consists of a polyethylene bottle with a blended filter of deionizing materials inserted in the neck like a stopper. When the container is filled with ordinary tap water, a quick squeeze produces a stream of chemically-pure water.

According to Machlett, "Deeminac" will remove all minerals and salts of calcium, sodium, iron, magnesium and other metallic ions, as well as sulfate, chloride, bicarbonate and silicate. "Deeminac" water, it is claimed, is equivalent in ionic purity to that produced by triple distillation. A special filter, which changes color when it has been consumed, will reportedly produce up to 20 gallons of chemically-pure water depending upon local conditions. The unit is completely portable.

Machlett states that "Deeminac" water may be used wherever deionized water is essential or desired. Such common items as storage batteries and electric steam irons may be serviced, it is claimed.

Available in 3 sizes——6 oz bottle with 2 oz filter; 8 oz bottle with 3 oz filter; and 16 oz bottle with 4 oz filter.

Descriptive literature is available upon request.

• Program for 3rd Canadian Textile Seminar Set

Progress in development of new textile fibers, machinery and textile manufacturing processes together with practical machinery, dyeing, finishing, research and other problems will be highlighted in over 30 papers to be delivered at the Third Canadian Textile Seminar at Queen's University, Kingston, Ont, September 11-13.

Advanced registration points to this third Seminar being widely attended from all sections of the primary textile industry both in Canada and the United States. F J Knight, vice-president and managing-director, Hubbard Felt Co Ltd, Montreal, general chairman of the Seminar, declared early in July that the committee had to set a limit of 500 on registrations.

Keynote speaker for the Seminar dinner on September 12th will be H H Lank, vice-president, Canadian Industries Ltd, and chairman of the executive committee, Canadian Chamber of Commerce.

Speakers who will present papers and preside at Seminar discussion groups are as follows:

Cotton Manufacturing:—Paul C Grant, Jr, Whitin Machine Works, Whitinsville, Mass; Francis L Gerdes, cotton technologist and director of research, U S Dept of Agriculture, Washington, D C; and F Preysch, J J Reiter & Co Ltd.

Cotton & Rayon Dyeing and Finishing:—E Sewell, Dominion Textile Co Ltd; E A W Boyce, Dominion Textile Co Ltd; and Dr Charles J Weidman, Ciba Co Ltd.

Knitting:—J H Blore, Provincial Institute of Textiles, Hamilton, Ont; R C Honour, W J Westaway Co Ltd; and R C Franklin, David Gessner Co.

Man-Made Fibers:—Dr C E Coke, Courtaulds (Canada) Ltd; Earl Sault, Zephyr Textiles Ltd; Robert Burns, Celanese Corp of America and Celanese Central (South America), N Y; George Ward and Fred Fortess, Central Research & Development Dept, Celanese Corp of America, Summit, N J.

Mill Engineering:—B A Evans, Canadian Industries Ltd; and J M Roddy, Bigelow-Sanford Carpet Co Inc.

Canadian Research:—G W Graham, Canadian Industries Ltd; Dr G H Segall, Canadian Industries Ltd; Dr W M Palmer, Canadian Celanese Ltd; and A S Weatherburn, National Research Council

Wool Dyeing & Finishing:—Harold Lomas, Canadian Aniline & Extract Co Ltd; Dr Milton Harris and Dr Daniel Frishman, Harris Research Laboratories, Washington, D C; and Dr C S Whewell, Leeds University, England.

Mill Supervision:—Ralph Presgrave, York Knitting Mills Ltd; G B Bailey, J D Woods & Gordon Ltd; William B Sears, Werner Consultants, P O M Co; and E R Suttie, Canadian Cottons Ltd.

Woolen Manufacturing:—Charles H Wishart, Brinton-Peterboro Carpet Co Ltd; and Carl D Brandt, Whitin Machine Works, Whitinsville, Mass.

Worsted Manufacturing:—Dr J H Wakelin, Textile Research Institute, Princeton, N J; and James R Longstreet, chief textile engineer, Warner & Swasey Co, Cleveland, Ohio.

Abstracts of several of the papers to be presented follow:

COTTON & RAYON DYEING & FINISHING SECTION

G W Smiley, Dominion Textile Company Limited, *Chairman*

"Some Aspects of the Molten-Metal Process"

E Sewell, Dominion Textile Company, Ltd

General discussion on principles and practices of molten-metal dyeing process. Discussions on loss of metal; tension; speed in relation to change of shade; dyeing by the molten-metal process on mixed fibers; comparative costs of molten-metal dyeing as against dyeing by conventional methods; newer developments of the molten metal process in regard to yarn dyeing, etc.

"Complaints Common To a Cotton Textile Converting Plant"

E A W Boyce, Magog Print Works, Dominion Textile Company Limited

Effects on converting of the following: (a) Faults in Raw Cotton. (b) Yarn Faults. (c) Weaving Faults. (d) Processing Faults. General discussion on: (a) Fastness Properties. (b) Special Finishes. (c) Customer requirements and complaints referring to these finishes. (d) Labelling of consumer goods with regard to special properties, etc. (e) Education of public to special properties imparted to textiles. (f) Advertising.

"Study of European and American Processes of Dyeing and Finishing"

Charles J Weidmann, Ciba Company Limited

Dyeing and finishing methods for cotton fabrics used in Europe as contrasted with methods for cotton fabrics in North America. In Europe there is a transition from small production and high quality to increased production with the maintenance of the same high quality.

On the other hand, in North America, high production is the normal method and the trend is to improve the quality of the finished material.

These two basic principles are converging and should result in finished fabrics of low cost and improved quality.

MAN-MADE FIBERS SECTION

J E Kelly, Courtaulds (Canada) Limited, *Chairman*

"Properties and Processing of the Newer Man-Made Fibers"

C E Coke, Courtaulds (Canada) Limited

A discussion of properties and processing of nylon, Orlon, Dynel, Acrilan and Dacron. In addition, possible future trends in blending, and their effects on end uses will be discussed.

"Fiber Preparation and Blending"

Earl Sault, Zephyr Textiles Limited

The preparation and blending of natural and synthetic fibers is very much to the fore these days and the author will discuss it from the point of view of machine lay-out, end use and economics.

"The Dyeing and Finishing of Fabrics Containing Acetate Filament and/or Staple Fiber"

Robert Burns, Celanese Corporation of America and Celanese Central, (South America), New York

This paper will deal with all phases of dyeing and finishing of acetate and should fill a long felt need for pertinent and up-to-date information on this important subject.

WOOL DYEING AND FINISHING SECTION

G A Farley, Guelph Yarns Limited, *Chairman*

"Modern Dyeing Theories in Relation to the Function of Levelling Agents In Wool Dyeing"

Harold Lomas, Canadian Aniline & Extract Co Limited

Development of modern theories from the early electrical theories. Recent work on wool structure. Aggregation of dyes, diffusion in the liquid stage, physical and chemical adsorption, diffusion in the solid stage. Paper also deals with effects of acids, salts and surface active agents on these processes, penetration of dyes through capillaries and the types of levelling agents and their use in different problems.

"Stripping of Chrome and Metallized Dyestuffs"

Milton Harris & Daniel Frishman, Harris Research Laboratories, Washington, D C

Among the major problems in stripping of dyes from wool are the removal of chrome or metallized dyes and the prevention of degradation of the fiber during such processing. Recent developments along these lines are discussed.

"Observations on the Finishing of Blended Fabrics"

C S Whewell, Leeds University, England

The behavior of blended fabrics during standard wool finishing operations will be discussed, emphasizing modifications of technique necessary to obtain best results.

16-foot IBC Brush

• 16-Foot Brush for Carpet Shear

The cleaning of the backs of broad loom carpets and room-size rugs is accomplished by means of automatic shearing machines equipped with brushes to raise the thread for cutting and to remove thread when severed.

The illustrated brush, manufactured by Industrial Brush Company, Inc, Little Falls, N J, is sixteen feet long. Others range up to 22 feet in length. They consist of a metal core that reportedly will not sag or get out of alignment, and a bristle of nylon, tuft set in slotted metal and sealed in place with a waterproof cement.

The brushes are cleaned by flushing with water.

• Beckman Instruments Purchases Berkeley Scientific Company

The purchase of the business and assets of Berkeley Scientific Corporation, Richmond, California, by Beckman Instruments, Inc, South Pasadena, California, has been announced by Dr Arnold O Beckman, President.

The Berkeley Scientific Corporation has been dissolved and the operations will continue as the Berkeley Scientific Division of Beckman Instruments, Inc. No changes in management or personnel are contemplated. W K Rosenberry, founder and President of Berkeley Scientific, becomes a Vice-President of Beckman Instruments, Inc and will remain in charge of operations at the Richmond Plant, it is learned. With the addition of the new firm, the number of Beckman employees has now reportedly been increased to 1400.

Founded in 1945, Berkeley Scientific Corporation manufactures a line of electronic counting devices and related equipment. The company has just expanded into a new addition to its present plant in Richmond, which more than doubles floor space and triples productive capacity.

• Textile Colleges Supply Executives, NETF Scholarship Study Finds

Strong evidence that textile college education fits young men and women for leadership is presented in a recently-completed report by New England Textile Foundation. Officials of the Foundation, whose purpose is to ensure a steady flow of college-trained young executives and technicians for the textile trade, authorized the study as a check on the organization's progress.

To test the worth of textile college training in the light of the needs of the industry for new recruits, a sample list of graduates from one textile college was followed up exhaustively. Reported findings were that 70% of those investigated hold important positions in the textile industry, 17% are active in allied fields, and only 12% have deserted textiles for other interests. Broken down in detail, the sampling of 306 graduates shows them occupied as follows:

Textile Industry: 215
14 Mill Owners, 45 Presidents, 23 Vice Presidents, 30 General Managers, 26 Treasurers and Secretaries, 45 Plant Superintendents, 32 Directors of Research, Standards, Testing and Personnel

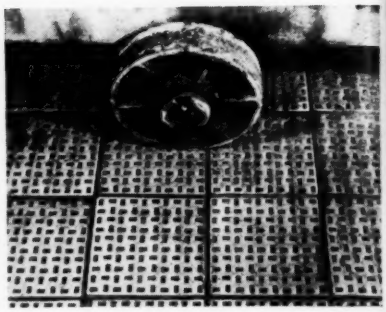
Suppliers to Textile Industry: 53
8 in Textile Machinery, 22 in Chemical Industries, 4 in Electrical Industry, 6 Publishers, 13 Engineers

Others: 38
5 in Finance, 11 in Education, 3 in Law, 12 in U. S. Government, 3 in Furniture, 4 in Medicine

As a feature of this year's campaign to obtain financial support from industrial management, NETF is offering a complete resumé of its youth-recruiting activities in a booklet titled "What Is He Worth to Your Business?" In addition to the report on how textile college training leads to executive positions, facts and figures are cited showing how the textile trade is currently benefiting from the services of former NETF scholarship holders. Copies of the booklet are available on request from New England Textile Foundation, 68 South Main Street, Providence 3, R I.

• Acme Steel Floor Surface Reinforcement

Acme Steel Company, Chicago, is currently producing an 11¾-in square floor plate of .068-in hot-rolled steel designed for the reinforcement and protection of concrete floor surfaces that are constantly subjected to heavy industrial loads and severe punishment.



Acme Steel Floor Plate

Floor Plate reportedly can be quickly installed as a new floor surface or over old floors without special tools. Initial installations in aisles, loading docks, elevator approaches, ramps and other heavily-trafficked areas reveal no appreciable wear after three years of abusive service, according to reports from Acme Steel.

Each plate contains 100 small rectangular holes approximately ½ x ¾ in and 100 barbed prongs ¾ in long, which anchor the plate firmly to the concrete. The four rounded edges of each plate form a flange that becomes imbedded in the concrete and adds rigidity to the plate. Area-wise, the surface of a concrete floor reinforced with this plate is said to be 74 percent steel and 26 percent concrete.

Because they were designed to fill one-foot increments of floor area, the manufacturer points out that there is no need for cutting to fit these plates around posts, machinery and corners. Floors protected with Floor Plate are said to be safe, whether wet or dry, because the abrasive characteristics of the exposed concrete provide resistance to slipping and skidding.

For new floors, after a dry concrete topping mix is poured over the base slab and screeded, the plates are pressed into the topping until pillows of concrete extrude upward through the holes. Plates are then leveled with floor surfaces and each other with 2 x 4 lumber. Finishing, to remove excess concrete, is accomplished with the edge of a steel trowel or a piece of folded burlap.

In installing Floor Plate over old concrete floors, the floor must first be chipped to a depth of approximately two inches and a slush bond coat brushed into the chipped surface before the topping mix is poured. After this, the procedure is the same as that for new floors. When sections of industrial floors must be removed to repair plumbing, steam and electrical lines, clogged sewers, etc, any plate or combination of plates can reportedly be removed without disturbing the rest of the floor surface.

Plates are packaged in cartons of 20. Shipping weight is approximately 65 lb.

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